POWER PLANT ENGINEERING

Established Over 34 Years

VOL. XXXIV CHICAGO, SEPTEMBER 15, 1930 No. 18

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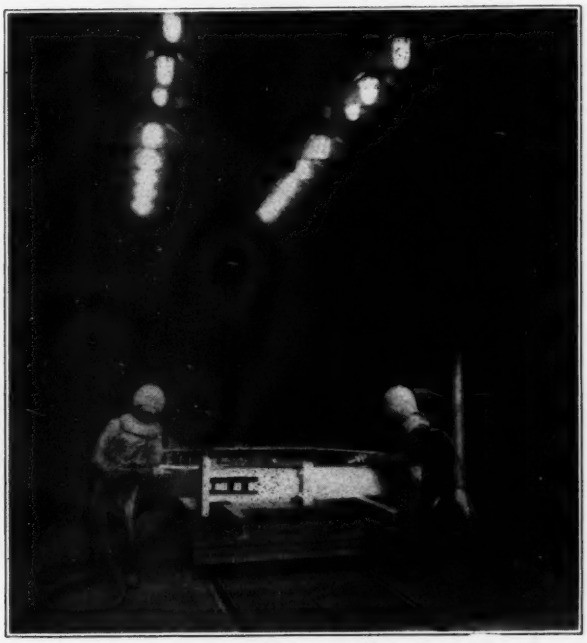


Ask Uncle Sam

IF YOU ARE at a loss to know what these fellows are doing, just get out your pen and write to Uncle Sam.

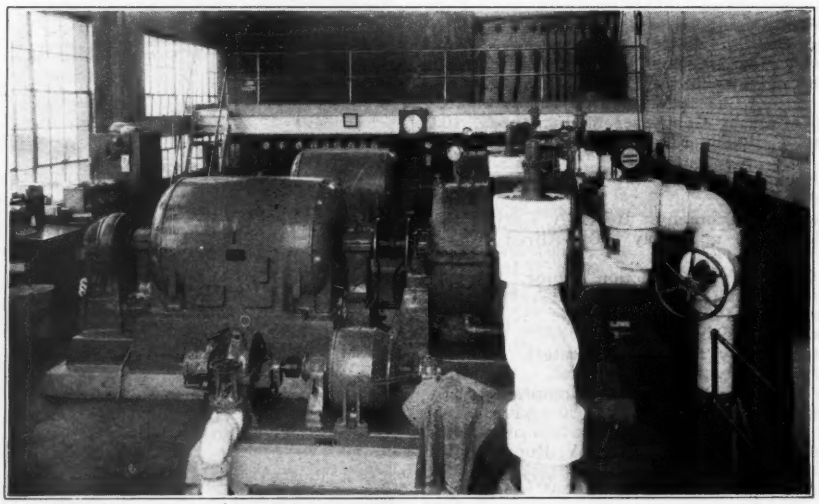
Many of us place little faith in some of Samuel's boys down in Washington; government red tape, politics, inefficiency and so on have had a lot of unfavorable publicity since the war.

They actually have some pretty smart and thorough fellows in the Department of Commerce. In a survey conducted in San Francisco they had the courage to classify drug stores among the restaurants. This should earn the unstinted praise of the entire country. They should now try to find out where it is possible to buy drugs, as this question, still unanswered, has been troubling 100 million people for several years.

Getting back to the subject, however, if you did write these bright fellows about the above picture, we feel sure you would be told that they are simply cleaning castings with steel shot. General Electric Co. goes a little farther and tells us that they are "peace-loving workmen" but it's pretty hard to make a Chicagoan believe that any man who shoots 100 lb. per min. of steel shot is peace loving.

This cleaning process is effective and we were rather under the impression that it was the method used by laundrymen on shirts. We are reliably informed, however, that this is not the case. If you are interested further in cleaning of shirts, turn to page 1031 of this issue where Mr. Sibley discusses the steam and power requirements of a modern laundry.

Titanium Pigment Plant *maintains* High Efficiency *under* Severe Load Conditions



AMONG THE MANY FINE industrial power plants which have been built in the vicinity of St. Louis during the past year, one of the most interesting, particularly from the standpoint of operation, is that serving the plant of the Titanium Pigment Co. This plant which is located at the mouth of River Des Peres just south of the city limits of St. Louis, Mo., has been in operation about a year and while it is subject to rather severe load requirements, it is characterized by an unusually high operating efficiency. While this high efficiency is due in part to certain features inherent in the design and construction of the plant, it is more the result of the excellent supervision given it by those in charge. This, of course, is true of any plant, no matter how high grade the equipment; unless a plant is given intelligent supervision and unless the chief engineer has the interest of his plant at heart, the best possible results cannot be obtained. The operating performance of a power plant usually reflects the skill and experience of the operator in charge.

This is particularly true of industrial power plants. Central stations, as a general rule, are very much alike—those built during a given period will usually have incorporated in them the same engineering features. This, however, cannot be said of the industrial plant since such a plant is usually designed and operated to meet the specific needs of the industry it serves. The operator of such a plant usually is free to work out his own ideas and while he may have had little to do with the design and construction, usually, if he is progressive and alive to the importance of his position, these ideas will be reflected in the operating performance of the plant.

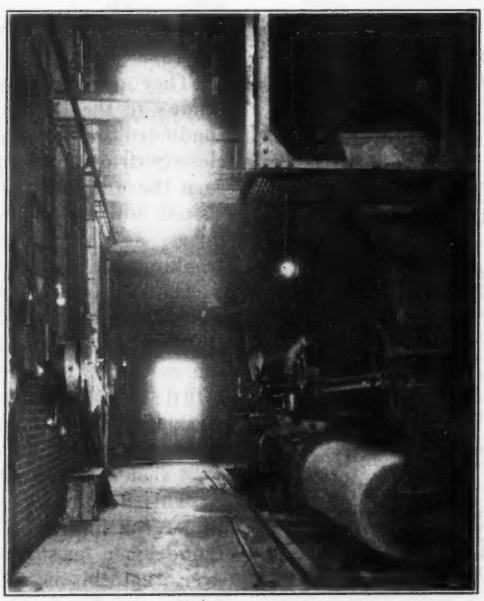


FIG. 1. EACH STOKER IS SERVED BY ITS AUTOMATIC COAL SCALE

This is true of the plant of the Titanium Pigment Co. Subject to load conditions which require its operation at practically full capacity 24 hr. a day, seven days a week, Frank C. Myers, the chief engineer, maintains a boiler

efficiency of 80 per cent. When it is considered that when he first took charge of the plant some 9 mo. ago, the boiler efficiency ran around 62 per cent, the influence of the operating engineer is readily apparent.

Before discussing the manner in which this excellent performance is maintained, it will be of interest to describe the general features of the plant. It consists essentially of a boiler and a turbine room on the same floor level with basement underneath, the principal equipment consisting of three 400-hp. water-tube boilers, stoker fired, and two 1000-kw. steam turbo-generator sets operating noncondensing at present, but equipped for bleeding steam for process work at 21 lb. pressure. Each boiler is equipped with a regenerative type air preheater and a Thermix stack.

denser will improve the economy of the turbine units. At the present time, steam is delivered to the turbine throttle at about 275 lb. pressure and 600 deg. F. From 200 to 250 deg. superheat is always maintained.

Boiler Room Equipment

Details of the boilers used and the setting are shown in the sectional views in Fig. 3. Each of the three units consists of a 400-hp. Combustion Engineering Corp., Casey-Hedges-Walsh-Weidner cross-drum type boiler equipped with Elesco superheaters and fired by Harrington chain grate stokers.

These stokers are of the multiple wind box type, having 5 separate wind boxes, hand controlled, for varying the amount of air passing through various parts of

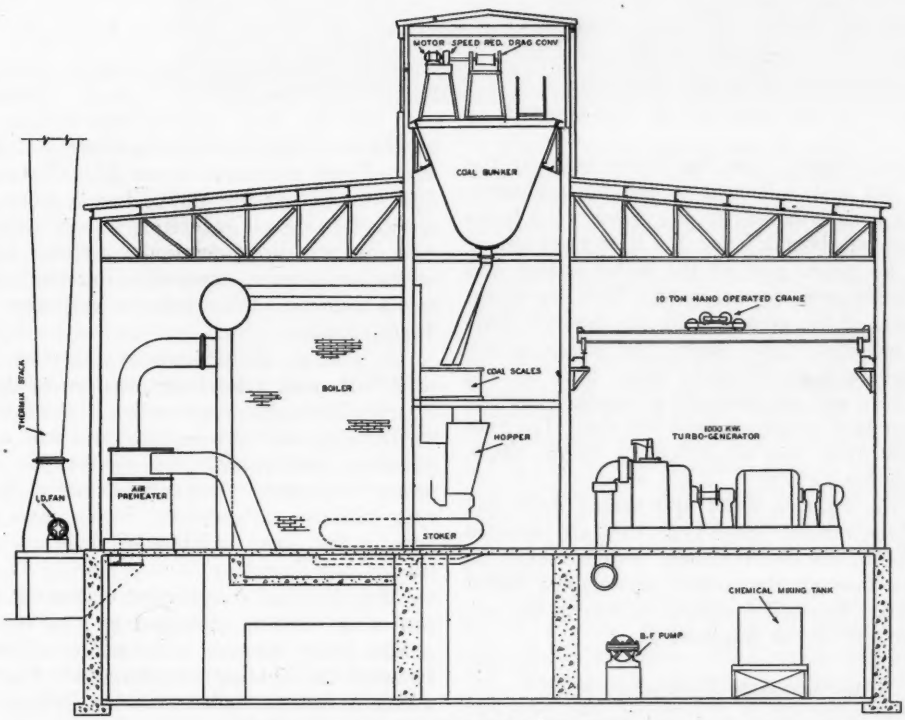


FIG. 2. CROSS-SECTION THROUGH PLANT

The plant is substantially constructed of brick, steel and concrete, is well lighted by large windows both in the boiler room and turbine room and presents an attractive appearance both inside and out. The three boilers are placed in a single row each one set separately and forming a complete unit with its forced and induced draft fans, air preheater and stack. The two turbo-generators are located side by side with their steam ends toward the boiler room. The electrical switchboard occupies one end of the turbine room while at the other end is located the water softening apparatus.

As already mentioned, at present the turbines are not equipped for condensing operation, but steam is bled at a pressure of 21 lb. and the exhaust sent to the feedwater heater. That which remains is wasted to the atmosphere—at present about 5000 lb. per hr. in summer. Condensers are to be installed, however, and while nearly all of the steam sent into the turbine will be extracted at 21 lb., that which does pass into the con-

the fuel bed. Each stoker is driven independently by its own engine, the driving units being Engberg 3 by 4-in. vertical steam engines running at 300 r.p.m. and driving the stoker through gears.

Boiler settings are of high grade fire brick throughout with Sil-O-Cel covering on top of the boilers. A vertical expansion joint at the center of the bridge wall is packed with asbestos. Forward from this point, the setting is of No. 1 firebrick and rearward, No. 2 firebrick. The furnaces are equipped with a water-cooled ignition arch and water-cooled side legs.

Both forced and induced draft are used, the former being supplied by Clarage fans driven by 30-hp. slip ring induction motors and the latter by fans built integral with the Thermix stacks. The arrangements of fans, air preheater and stack for each boiler is clearly shown in Fig. 4. The air preheater which is the Ljungstrom vertical type and the forced draft fans are mounted directly behind the boilers. Air for com-

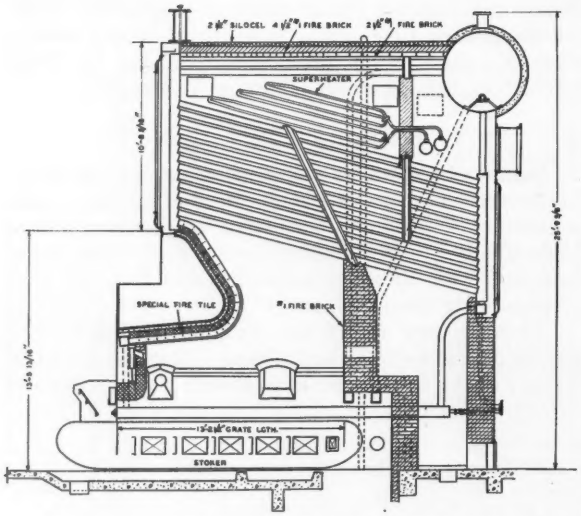


FIG. 3. SECTION THROUGH ONE OF THE BOILERS

bustion is taken directly from the boiler room by the forced draft fan and delivered to the air preheater, from which in turn it is sent to the stoker wind boxes at a temperature of about 325 deg. F. Flue gases are removed from the upper part of the boiler setting and drawn into the air preheater as shown. They are drawn from the bottom of the preheater by the induced draft fan which is mounted in the stack. The stacks, as has been mentioned, are the Thermix type made by the Prat-Daniel Corp. and are designed to handle 71,000 lb. of gas per hour at a temperature of 385 deg. The fans operate at 1160 r.p.m. and are driven by 25-hp., 440-v. slip ring induction motors.

Although the induced draft and forced draft fan motors are of the variable speed type, they are operated at constant speed, the boiler control system regulating the air supply through the control of dampers rather than fan speed. The boiler control system is the balanced draft system of The Engineer Co.

Coal and Ash Handling

The method of handling coal and disposing of the ash is simple and effective. Coal, delivered by railroad car, is dumped into a track hopper from a trestle adjacent to the boiler room and by means of a short apron conveyor is delivered to a vertical bucket elevator to the top of the boiler room, where a drag scraper conveyor delivers it to the overhead bunkers. Illinois coal is burned. From the overhead bunkers, the coal drops through chutes to Richardson automatic coal scales and thus into the stoker hoppers, the latter being equipped with graduated gates so that the fireman may gage the thickness of the fuel bed. Each boiler unit has its individual coal scale, permanently installed above the stoker hoppers.

Ash is removed from the ash hoppers in the boiler room basement by simply opening the ash gates and permitting it to fall by gravity into an industrial car below.

Water used for boiler feed is Mississippi River water, treated in a Cochrane hot process, lime-soda system. This equipment is installed in the turbine room and turbine room basement, filter and chemical mixing tanks being in the basement and the treating tank proper together with the feedwater heater and the Cochrane V-notch meter in the turbine room above. This water treating system has a treating capacity of 100,000 lb. per hr. and the water is heated to a temperature of 210 deg. F.

There are two boiler feed pumps, one a Dean Hill centrifugal unit driven by a 60-hp., 440-v. Allis-Chalmers motor, the other a similar unit driven by a Dean Hill steam turbine. These units are located in the turbine room basement.

Water level in the boiler is controlled by Swartwout S-C feedwater regulators. In addition to the feedwater regulator, each boiler is equipped with Ashcroft safety valves, Bayer soot blowers, Yarway blowoff valves and a Reliance water column.

Turbine Room Features

Two 1000-kw. turbo-generators generate all electricity used throughout the plant. These each consist of a 1000-kw. Terry bleeder type turbine taking steam at 275 lb. pressure and exhausting at 1 lb. back pressure, direct connected to an Allis-Chalmers Mfg. Co., 1000-kw., 80 per cent power factor, 480-v., 3-phase, 60-cycle, 3600-r.p.m. generator. Each unit is provided with its own direct connected exciter. For emergency excitation, a spare, steam driven exciter is installed, this being a 25-kw. Allis-Chalmers generator driven by a Terry turbine.

At present, the turbines are operated at a pressure of 275 lb. and a total temperature of about 600 deg. Nearly all of the steam supplied to the turbine is bled at 21 lb. pressure. These machines are equipped with Precision indicating thermometers for showing total steam temperature, and with James G. Biddle, Frahm type vibration tachometers. Steam gages showing pressure in first stage and bleeder stage are mounted on a nearby gage board.

The electrical switchboard, is located at one end of the room; this is arranged in two tiers, the upper section being mounted on a gallery on which are also installed the lighting transformers. The lower section which is located underneath the gallery consists of a

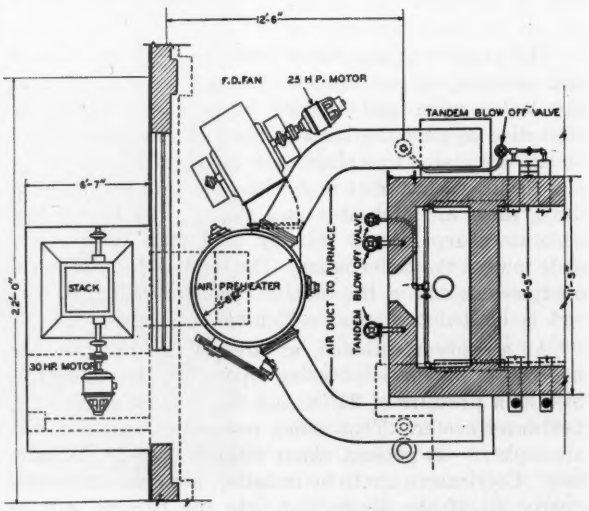


FIG. 4. PLAN OF THE FORCED AND INDUCED DRAFT EQUIPMENT AND AIR PREHEATER

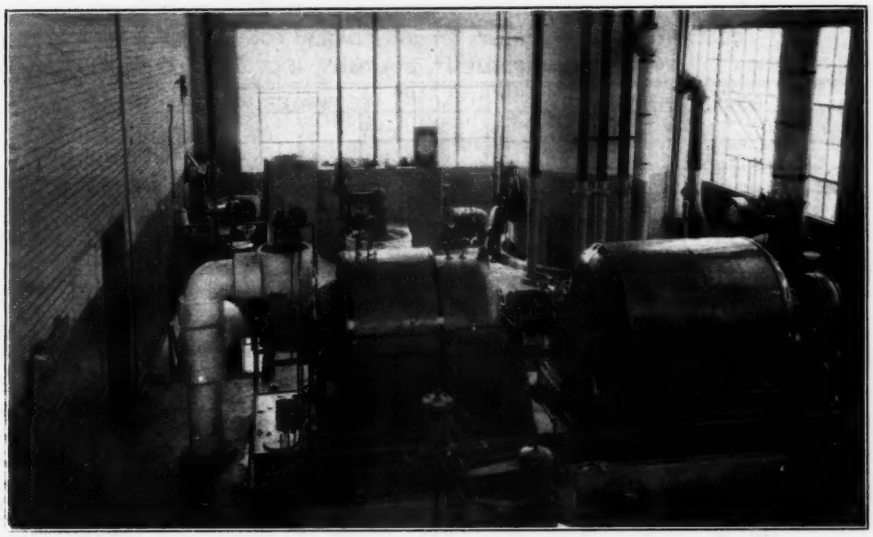


FIG. 5. A GENERAL VIEW OF THE TURBINE ROOM SHOWING WATER TREATING TANK IN BACKGROUND

voltage regulator panel, an auxiliary exciter panel, a main exciter panel, two generator panels, a blank panel, for future generator, a recording voltmeter and power factor meter panel, and eight feeder panels. The upper section consists entirely of feeder panels.

All electric distribution from the power plant to the various factory buildings is at generator voltage, 455 v. The only transformers installed are those for reducing this voltage to that required for lighting.

At the opposite end of the turbine room from this switchboard is installed the water treating sedimentation tank and the Cochrane V-notch meter. The feedwater heater is of the standard Cochrane design mounted on top of the sedimentation tank.

Operation

The normal electrical load on the plant is 1000 kw. This load must be maintained practically 24 hours a day seven days a week. Each turbine, therefore, is just large enough to carry the load.

In order to insure continuity of service, it is the practice never to use more than one machine at a time. One turbine unit is operated at full load for a week, when it is shut down, and the other machine placed in service.

FIG. 6. ONE OF THE BOILER FEED PUMPS, AND THE WATER TREATING APPARATUS IN THE BASEMENT

This is rather severe service and the turbines must be maintained in perfect condition at all times. As soon as one machine is taken off the line, it is thoroughly inspected and adjusted so as to be in condition to take on the load at an instant's notice. Because of the large number of induction motors used in the plant, the power factor is lower than might be desired, running around 75 per cent at present. As this imposes additional work on the turbines, steps are to be taken in the near future to raise this value by the installation of either synchronous motors or static condensers.

Operation of the boilers is effected in a manner similar to that of the turbines; that is, one unit is always kept in reserve. A boiler is operated continuously for three weeks and is then shut down for a week. Two boilers are always in service while one is being overhauled.

Perhaps the first essential in securing efficient operation in a power plant is that of obtaining the coöperation of the operators—the firemen, turbine attendants, etc. They must not only be instructed as to their duties but must take an interest in maintaining the operating efficiency at the highest value. Second, perhaps, is that of having available such instruments as are necessary to determine the conditions of operation in the various equipments comprising the plant.

Both of these requirements are met in the Titanium Pigment Plant, to a satisfying degree. In the boiler room, there are instruments showing steam flow and pressure, CO_2 draft and temperature of air to boilers. In the turbine room are instruments for steam temperature, feedwater temperature, and quantity used. The water is tested for hardness and the coal analyzed at frequent intervals, as is also the ash.

There is installed on each boiler, a Hays, 7-point multiple draft gage, giving pressures not only in the five wind boxes under each stoker but also the pressure over the fire and in the last boiler pass. CO_2 is recorded by a Hays automatic CO_2 and draft recorder, one for each boiler. A Cochrane flowmeter on each boiler records both steam flow and temperature. Coal is measured automatically by Richardson coal scales installed above each stoker.

SHIFT NO. (FROM M TO M) DAILY POWER REPORT DATE

TITANIUM PIGMENT COMPANY, INC. ST. LOUIS PLANT

BOILER OPERATION						TOTAL
BOILER	NO. 1	HR. PLUS	=			
	NO 2	" "	=			
	NO 3		=			
PRESS. BOILER	NO. 1				LB.	
	NO. 2				LB.	
	NO. 3				LB.	
FEED WATER					°F.	
FLUE GAS	NO. 1				°F.	
	NO. 2				°F.	
	NO. 3				°F	
CO_2	NO. 1				%	
	NO. 2				%	
	NO. 3				%	
AIR TO BLR.	NO. 1				°F	
	NO. 2				°F.	
	NO 3				°F	

FEED WATER METER			
OUT	IN	DIFF.	
COAL METERS			
OUT	IN	DIFF.	
BOILER FEED PUMPS			
ELECTRIC		STEAM	
HR		HR	
FLUSHED AIR FILTER			
A M		P M	
REMARKS:-			

TURBINE OPERATION					TOTAL
TURBINES	NO. 1	HR. PLUS	=		
OPERATING	NO 2	" "	=		
THROTTLE PRES.					LB.
STM. TEMP.					
BLEEDER PRESS.					LB.
EXHAUST "					LB.
TOTAL KW.					KW.
AMPERES					AMP.
VOLTS					V.
POWER FACTOR					%
CYCLES					

STEAM FLOW METERS			
	OUT	IN	DIFF
SUP. HTR.			
BOILERS NO. 1			
NO. 2			
NO. 3			
TOTAL			
SAT. STEAM			
BLEEDER			

ELECTRICAL METERS				
DEPT.	FAC.	OUT	IN	DIFF.
PWR. HOUSE				
SHIPPING				
CALCINING				
OLIVERS				
PIGMENT				
ORE				
WATER				
BLACK ASH				
DORR TNKS				
OLD. BLR. RM.				
LIGHTING				
TOTAL				

SIGN. ENGR.

COAL RECEIVED	WEIGHT		DUMPED TO		REMARKS
CAR NO.	GROSS	NET	STORAGE	BUNKER	

FIG. 7. DAILY POWER REPORT

CHIEF ENGINEER'S POWER SUMMARY

TITANIUM PIGMENT COMPANY, INC. ST. LOUIS PLANT DATE

	SHIFT	FACTORS INT.	COR.	AVE. PRESS	READINGS	TOTAL LB. DAY	FACTOR OF EVAP.	TOTAL LB. FROM AND AT 212°	CARRIED FWD.	TOTAL LB. TO DATE
COAL BURNED	1	200								
	2									
	3									
TOTAL										
V-NOTCH WATER METER	1	1250								
	2									
	3									
TOTAL										
SUPER-HEATED	1	350								
	2									
	3									
TOTAL										
SATURATD STEAM	1	100								
	2									
	3									
TOTAL										
BLEEDER STEAM	1									
	2									
	3									
TOTAL										

	SHIFT	%	POUNDS	FACTOR	STM. EQUIV.	PREVIOUS	TOTAL LB. TO DATE	COAL EQUIV.	PREVIOUS	LB. TO DATE
BLOW DNS										

BOILER NO.	BOILER HR. TO DATE	AVERAGE CONCENTRATN	TURBINE NO.	TURBINE HR. TO DATE	KW. FOR DAY	PREVIOUS	KW. TO DATE	PLANT WATER IN CU. FT.
1			1					FOR DAY:-
2			2					PREVIOUS:-
3			LOAD FACTOR (100% = 1200 KW AT 80% P.F.)					TO DATE:-

AVERAGE LB. STEAM GENERATED PER LB. COAL AS FIRED

AVERAGE LB. STEAM GENERATED PER KW. HR.

REMARKS:-

FIG. 8. CHIEF ENGINEER'S SUMMARY

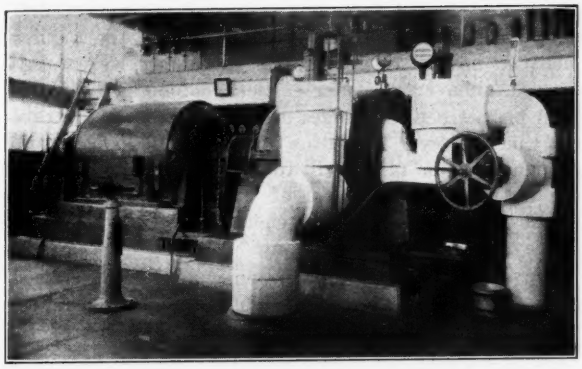


FIG. 9. ONE OF THE 1000-KW. TURBO-GENERATORS

Thus, all provision is made for an accurate check upon the amount of coal consumed, the amount of steam produced and the efficiency of combustion. The coal used runs about 11,500 B.t.u. per lb. Samples of the coal used are taken at various intervals, these being averaged and analyzed once every two weeks.

CO_2 over the fire at the present time is maintained at about 14 per cent and the Engineer Co. balanced draft system maintains an over fire draft of about 0.1 in. Air for combustion is heated to 325 deg. F. Under these conditions, the stack temperature is about 600 deg.

The boiler water concentration is watched carefully and the boilers are blown down in accordance with the results of these concentration tests. The actual concentration is kept as nearly to 250 gr. per gal. as possible. Boiler water is analyzed for concentration 12 times a day. The treated water is tested 6 times a day.

All testing and reading of meters is done by the operators themselves. In the boiler room practically all operation is automatic and about the only thing the fireman has to do is to watch his coal to the stokers. All his other duties are definitely laid out for him.

Each day, the day's requirements for operation are recorded on a bulletin board. Typical instructions, for instance, will require that the CO_2 be held to 14 per cent and boiler concentration at 250. These values may be changed from day to day as conditions demand. A set of printed instructions is posted on the bulletin board which the firemen must adhere to at all times. A copy of these instructions is shown herewith. An examination of these rules will disclose the fact that the firemen cannot go wrong if they adhere to them.

POINTS ON CORRECT HANDLING OF BOILERS

1. The automatic regulators are adjusted to speed up the fans and stoker engines at 260 lb., and slow them down at 270 lb. Do not tinker with the weights, that's one sure way of getting into trouble.
2. The engine governors are adjusted to hold the speed at 400 r.p.m. Above this speed, you cannot efficiently burn the coal being fired.
3. The proper handling of the coal gates means much towards a straight steam line; usually about ¼ in. on the gate for each 100 kw. load will give ample fire.
4. Use good judgment in handling the stoker engine bypass valves. Adjust the steam so the stoker will just hold the fire and steam constant. With a 1000-kw. load and an 8-in. gate, about 150 r.p.m. will practically hold the steam between high and low regulator positions, *the ideal operation.*
5. At the full-speed position of the fans, adjust wind boxes 1, 2 and 3 (see indicators) to hold the CO_2 at the per cent marked on the bulletin board and you will find that the air will practically take care of itself.
6. Avoid excessive blowing down. Blow down just enough to hold the concentration as marked on the bulletin board.
7. By careful adjustment of the coal gates and stoker engine bypass valves the steam will be held nearly constant, thereby avoiding the waste due to the safety valves operating. Every time they pop it means one or more dollars wasted.
8. *Study the* CO_2 *recorders.* A long line means too much air and a short line shows a lack of air.
9. Remember that the boilers are designed so that at 300 per cent rating a full grate of fire is required, and at 150 per cent rating only one-half the grate is needed.
10. Have your boilers performing so well that the incoming firemen will not find it necessary to make any changes in the gates, or stoker speeds, or wind boxes.

Study your work—it's your living.

TYPICAL SET OF CALCULATIONS

April 15, 1930

Typical Set of Calculations

Coal

D - 17.5 -- 35000. Hale
E - 14.0 -- 29200. Kern
N - 14.7 -- 29400. Smith
46.8 93600#
200.
93600#

Water Meter - 97b

Warren - D - 248 - 910000. 1250.
Miller - E - 216 - 870000. 33750
Taylor - N - 211 - 863750. 1350
675 843750. 97b
843750#
V-notch

Super Steam #1-1233. #3- 726.

D - 951 1959
E - 639 320
N - 369 97950.
1959 5877
685650#

Sat. Steam 1748. 56.

D - 586 10488
E - 581 8740
N - 581 97385#
1748
Sat. Steam to Plant

Blow downs

D - 274 - 6.20 - 19,200.
E - 279 - 6.10 - 16,500.
N - 281 - 6.52 - 17,400.
271 6.27% 53,100#

Total Eva. at 97b

685,650.
97,888.
53,100.
836,638#

Eva. lb. coal

836,500 / 93,600 = 8.93

K.W.H.

D - 5080.
E - 4530.
N - 3970.
14080.

Bleeder - 712

D - 251 400
E - 228 284,800
N - 233
712 Bleeder to Plant

Steam K.W.H. 48.8

LF. .469

BD Coal 1062#

Plant Water 200,817. cu.ft.

685,650. x .964 = 662337.9 x 1.22 = 808052
97,888. x 1.052 = 102978
284,800. x .845 = 240,656 x 1.02 = 245,469
53,100. x 1.02 = 54,162

A perpetual inventory of all commodities (steam, water, coal, kw-hr., etc.) handled is kept by means of an unusually complete set of record forms. Samples of these forms are reproduced in Figs. 7 and 8. Readings are taken frequently and by means of these records, the engineer in charge is able to strike a heat balance of the plant within an hour of the time it is requested. In other words at any moment he is able to state definitely just how much water, or coal or kw-hr. were produced that day, week or month. A chief engineers summary is turned in to the manager each day from which in turn a monthly report is prepared for submission to the New York office.

A typical set of calculations is shown herewith. These show values for April 15, 1930. At the top are seen the meter readings determining the amount of coal and water used. Below that are figures showing the amount of superheated and saturated steam produced—at the left is the superheated steam to the turbine; at the right, the saturated steam to the plant.

To obtain the total evaporation, it is necessary to

add to the saturated and superheated steam produced, the amount of blowdown. This is done as the third division. Dividing the resultant figure (836,600 in this case) by the amount of coal burned (93,600 lb.) gives the evaporation of water per pound of coal as 8.93.

The remaining figures give the steam per kw-hr., the load factor and the amount of coal to be charged to blow down. Below are shown evaporation figures for various services brought down to "from and at 212 deg."

Steam to the factory which is bled from the turbine is measured by a Cochrane flow meter and the pressure recorded by a Bristol recording pressure gage. In addition to the bleeder steam used, a considerable amount of saturated steam is delivered to the factory directly from the boilers.

As stated at the beginning of this article, at this plant, despite the fact that a certain amount of difficulty has been encountered and even with the requirement of having to operate 24 hr. a day, seven days a week, an average boiler efficiency of 80 per cent has been maintained. Changes are being made at the present time, however, by virtue of which it is expected the efficiency can be raised still further. The plant is under the immediate supervision of Frank C. Meyers, chief engineer, and under the general direction of W. S. Libbey, chief engineer of plant.

In presenting this description, we wish to acknowledge our indebtedness to Mr. Libbey and Mr. Meyers as well as to A. S. Moses, the general manager of the Titanium plant, for courtesies extended and assistance rendered in collecting the data on which this article is based.

Improving the Laundry Heat Balance

HINTS AS TO THE WAYS IN WHICH ENGINEERS CAN UTILIZE MODERN EQUIPMENT TO GET LOWER COSTS. BY E. F. SIBLEY*

RECENT TECHNICAL advances in the laundry industry, which have had the effect of increasing the amount of steam required for power as against that required for heating purposes, present new problems in the matter of obtaining an economical heat balance.

While it is not to be expected that a small, isolated power unit in a laundry can be operated as efficiently as, for example, the closely watched, highly organized power plant of a public utility, nevertheless conditions formerly prevailing in laundry plants have been extremely favorable to obtaining a good heat balance. The large amount of heat usually lost in the form of exhaust steam from the power unit could in laundries be used for heating the large amounts of hot water needed in the washing process. So long as the amount of steam required for heating water exceeded the amount of exhaust steam available, loss of heat in exhaust steam could practically be eliminated. It was also economically possible to use engines with a relatively high steam consumption compared with the power output.

But the development of the industry is changing this situation. Power operated machines are replacing hand and foot operated equipment; electrical heating is replacing gas heating while conveyors and other labor-saving devices are coming into greater and greater use. With the relative increase in the amount of power used for a given volume of laundry work, it has been found, where ordinary slide valve engines are used, that there will be an excess of exhaust steam.

In addition, the introduction of waste water heat reclaimers has reduced the amount of steam required for heating water. From one-third to one-half of the required heat can be obtained from waste water passing through the heat reclaimer.

The accompanying diagram visualizes the heat flow between the various units of the laundry. The flow of heat through the plant is shown by a band, the width of which is proportioned to the amount of heat at each particular point. The locations of the various heat losses, together with their relative importance, are indicated.

COMBUSTION LOSSES ARE OFTEN 35 PER CENT OR MORE

Initial loss occurs, of course, in combustion. When coal is burned under a boiler, some heat is lost from unburned coal falling into the ashpit. More heat is lost by radiation from the boiler and furnace walls. The greatest loss, however, is the stack loss. Some of the heat that goes up the stack is useful, in that it produces the necessary draft for the fire. With improper combustion or an excess of air, the stack loss will often be as high as 35 per cent of the total heat in the coal burned under the boiler. With the proper firing, the stack loss can be kept at a minimum. In the diagram the preventable loss is indicated by a dotted line.

Steam produced by the boiler is divided into two main parts—the steam for heating the laundry machines and the steam for operating the power unit. Of the heat in the steam going to the various laundry machines, better than half is lost in radiation. In the winter time this radiated heat helps to warm the building, but in the summer months it is not only a loss but an actual discomfort to the operators.

Exhaust steam from the engine is shown on the chart as going to the hot-water heater. In the particular case assumed by the chart, the exhaust steam would be insufficient to supply the amount of hot water required. From the heater the diagram shows the hot water as passing through the wash room and the heat exchanger or reclaimer. Slightly more than half of the heat in the waste water is shown as being recovered and passed on to the hot-water heater in the form of preheated clean water. The balance of the heat in the water is lost to the sewer.

Depending on the capacity of the heat reclaimer, more or less heat can be recovered from the waste water. With an engine developing a given amount of power and

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exhausting a given quantity of steam, there is no economy in recovering from the waste water any more heat than necessary to produce the required amount of hot water. If a greater amount of heat is recovered than necessary, all the exhaust steam over the necessary amount will be lost through the roof exhaust.

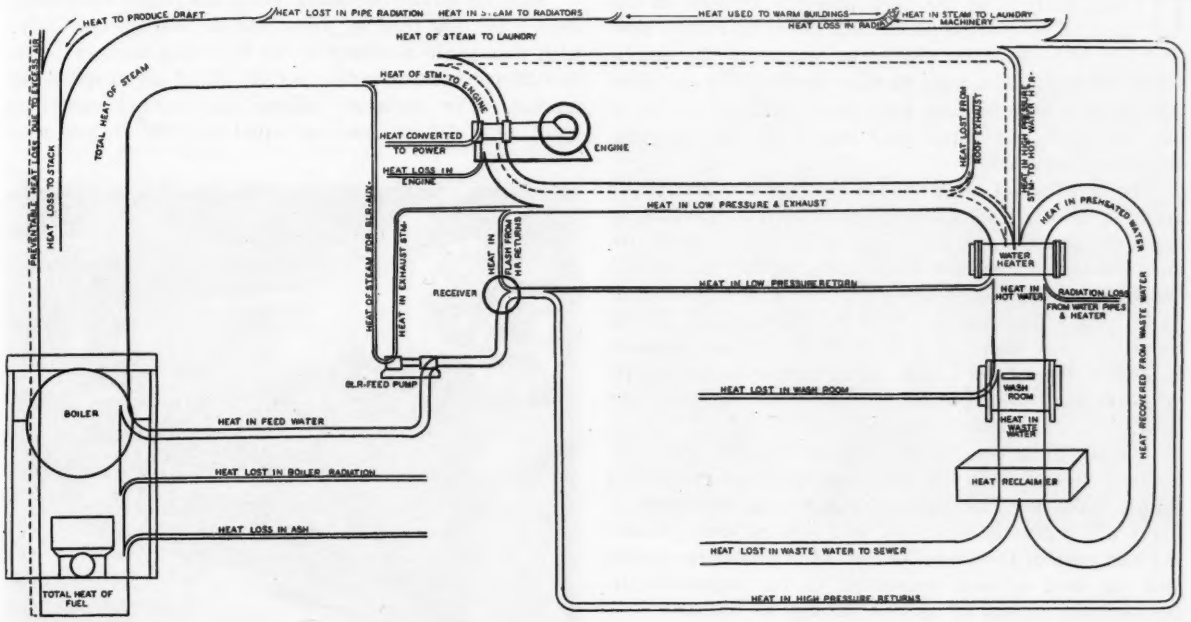
The more economical the engine, the smaller will be the amount of exhaust steam, and a proportionately greater saving can be made by increasing the amount of heat recovered from the waste water. The higher cost of the more economical engine and the larger heat reclaimer must, however, be balanced against the lower cost of a smaller boiler and the saving in fuel brought about by the smaller steam consumption of the engine.

In large finish work plants, where considerable power is required and where ordinarily there would still be an excess of exhaust steam, even with an engine of the best type, a number of things can be done to reduce the amount of exhaust steam available and make possible the use of a heat reclaimer for recovering and using a large portion of the heat in the waste water.

By increasing the initial or boiler pressure and by reducing the back pressure with the proper design of water heating equipment, the steam consumption of the engine can be greatly reduced. By replacing steam-driven auxiliaries, such as boiler feed pumps, steam-driven air compressors and stokers, with electrically-driven auxiliaries, the exhaust steam which would be obtained from such steam-driven equipment can be reduced. Steam-driven auxiliaries, while simple to operate and extremely reliable, often consume from two to five times as much steam as would be required by the engine to accomplish the same result with motor-driven equipment.

In winter excess exhaust steam can be used for heating the building, but this is of little importance. There is always a greater need for steam for heating water in the winter than in the summer. This takes care of any winter excess of exhaust steam, but what is needed is an all-year-round use for exhaust steam. Laundry machinery companies are now working on tumbler dryers that will operate on exhaust steam. As a tumbler requires 15 to 20 b-hp. per hr. and this additional amount of heat can be recovered from the waste water, if the exhaust steam is used elsewhere utilization will reduce the live steam load proportionately.

During such periods as an engine is operating at light load and the demand for hot water is greater than can be supplied by the exhaust steam, the live steam can be used to furnish the necessary heat as indicated by the dotted lines on the diagram.


HEAT TO PRODUCE DRAFT
HEAT LOST IN PIPE RADIATION
HEAT IN STEAM TO RADIATORS
HEAT USED TO WARM BUILDINGS
HEAT LOSS IN RADIATORS
HEAT IN STEAM TO LAUNDRY MACHINERY
HEAT OF STEAM TO LAUNDRY
TOTAL HEAT OF STEAM
HEAT LOSS TO STACK
HEAT OF STEAM TO ENGINE
HEAT CONVERTED TO POWER
ENGINE
HEAT LOSS IN ENGINE
HEAT LOST FROM ROOF EXHAUST
HEAT IN LOW PRESSURE & EXHAUST
HEAT IN EXHAUST STEAM
HEAT IN FLASH FROM H.P. RETURNS
RECEIVER
WATER HEATER
HEAT IN PREHEATED WATER
HEAT IN LOW PRESSURE RETURN
HEAT IN HOT WATER
RADIATION LOSS FROM WATER PIPES & HEATER
B.F. FEED PUMP
BOILER
HEAT IN FEED WATER
HEAT LOST IN WASH ROOM
WASH ROOM
HEAT IN WASTE WATER
HEAT LOST IN BOILER RADIATION
HEAT RECLAIMER
HEAT RECOVERED FROM WASTE WATER
HEAT LOSS IN ASH
HEAT LOST IN WASTE WATER TO SEWER
TOTAL HEAT OF FUEL
HEAT IN HIGH PRESSURE RETURNS

HEAT FLOW DIAGRAM OF A MODERN LAUNDRY. WIDTH OF BAND IS PROPORTIONAL TO HEAT FLOW

It will be noted in the diagram that there is a small amount of heat entering the hot-water heater in the form of live steam, while there is at the same time an indication of some exhaust steam being lost through the roof. This is not an unusual condition. Both the supply of exhaust steam and the need for hot water vary, independently of each other, and live steam is usually required to maintain a constant temperature.

Recently, however, water heating systems have been developed that will maintain a constant water temperature without the use of live steam, as long as there is sufficient exhaust steam to meet the average hourly requirements. The loss of heat due to the use of live steam being used to maintain a constant water temperature is often considerably greater than as indicated on the diagram and these water heating systems make possible a considerable saving in fuel.

Prevention of unnecessary heat loss in the laundry industry requires, in the last analysis, a study of the requirements of each plant. These problems are complicated by seasonable variations in the amount of steam

required for heating water; more heat is required in winter than in summer while there is even a variation in the power and hot-water requirements within a single week. In the early part of the week, there is a large volume of washing being done, requiring heat in the form of hot water. At the end of the week, washing largely gives way to ironing and finishing processes, which require heat in the form of power. Moreover, due to variations in the services offered by laundries, some require more power in proportion to washing than others. The problems of each laundry must be solved on a basis of its particular requirements .

Steam Turbines Pay Dividends in Paper Mills

POWER AND STEAM REQUIREMENTS OF NEWSPRINT MILLS FORM LARGE PART OF TOTAL COST OF PAPER. DETAILS OF TURBINE WHICH SAVED $20,000 INVESTMENT IN LESS THAN A YEAR. BY THOMAS PARKS*

UTILIZATION of the back pressure turbine in the modern newsprint paper mill offers attractive possibilities because of its ability to cope with the conditions ordinarily met with in that service. As an illustration of a specific case with facts that should prove interesting to the paper mill engineer, the following article is presented.

We will first of all direct our attention to the paper machine proper and without entering into the subject too deeply, deal with the steam and electric power requirements for this machine, which in this case is 234 in. wide, capable of producing 125 t. of newsprint per 24 hr. at a linear speed of 1000 ft. per min. and a daily steam consumption of 1,000,000 lb. of low-pressure steam for drying the paper. This is equivalent to 4 lb. of steam per pound of paper or 42,000 lb. of steam per hour.

To obtain a comprehensive idea of the power requirements involved, the following data are given in a simple manner. The high-speed newsprint machines of today are generally equipped with electric drive, meaning that each of the seven sections of the machine proper and the reel is each connected to its respective direct-current motors of various ratings as follows:

	Motor Size	Total Hp.
Couch	200 hp.	200
Three press sections	125 hp.	375
Two dryers	190 hp.	380
Calender	190 hp.	190
Reel	65 hp.	65
Total installed		1210

Actual horsepower loads at 1000 ft. per min. paper speed:

Couch	120 hp.
Three press sections	210 hp.
Two dryers	120 hp.
Calender	120 hp.
Reel	30 hp.
Total	600 hp.

In passing, it may be noted that the motor ratings are approximately 50 per cent in excess of the actual power requirements for driving the different sections. Poor efficiency, one not familiar with this particular kind of work would say. It is, however, considered as being first-class engineering practice for reasons best known to the paper mill engineers.

*Engineer, Hawley Pulp & Paper Co., Oregon City, Ore.

Electric power necessary when the paper machine is driven by this type of drive can be readily calculated with reasonable accuracy in the following manner: Hp. = 0.25 per inch of width[1] per 100 ft. of paper speed per minute. For instance, assume the normal operating speed of a 234-in. machine equal to 1000 ft. per min.

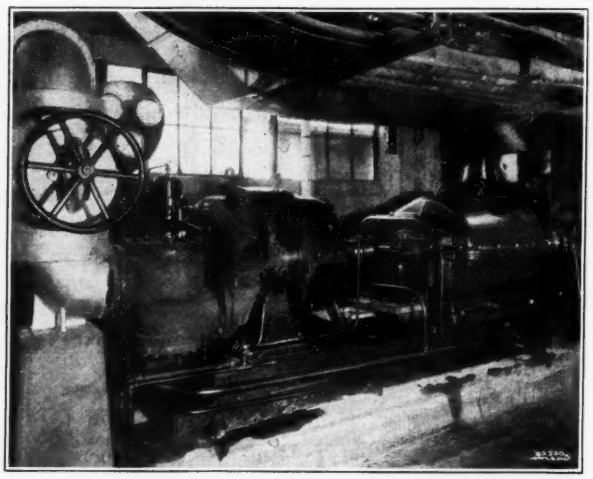


FIG. 1. GENERAL VIEW OF THE TURBINE AS INSTALLED

Power required then would be equal to $0.25 \times 234 \times (1000 \div 100) = 585$ hp. This checks closely with 600 hp. actually used.

In addition to the direct-current power requirements for the paper machine, closely related auxiliary equipment such as jordans, screens, vacuum pumps, fresh water pumps, white water pumps and stock pumps, require approximately 1000 hp. for which alternating-current motors ranging from 5 to 200 hp. are invariably used.

The paper machine and its immediate auxiliaries are only one part of the whole mill. A fairly accurate figure for estimating the power for the whole mill per ton of finished newsprint per 24 hr. may be taken as 85 hp.; 60 hp. being allocated to the grinders or ground wood plant; 5 hp. for the sulphite plant; 15 hp. for maximum speed of machine and 5 for miscellaneous requirements.

This article is primarily concerned with the power requirements of the paper machine and its immediate auxiliaries only. This power on the basis of a paper

[1]This value varies from about 0.23 to 0.35 depending upon the type of machine, kind of drive and composition and thickness of the paper.

speed of 1000 ft. per min. is 600 hp. for the paper machine plus 1000 hp. for its immediate auxiliaries, making a total of 1600 hp. or on the basis of 125 t. of paper a power requirement of approximately 13 hp. per t. of paper machine capacity per day. This checks fairly well with the usual assumption of 15 hp. as stated in the paragraph above for maximum speed of machine. Power for the whole mill being about 85 hp. for 24 hr. or 2040 hp-hr. total per ton of paper, each pound of paper consumes about 1 hp-hr.

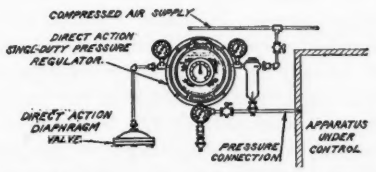


FIG. 2. DETAILS OF THE AUXILIARY BACK PRESSURE CONTROL

When we consider that newsprint represents something like 85 per cent of the total tonnage of paper products in America, it is easy to see why the paper manufacturers are greatly concerned regarding the cost per ton in which steam and electric power play such an important part. Hydroelectric power carries most of the load in many paper mills, but as quantities of low-pressure steam are required for drying the paper, it has been found economical to use steam prime movers for driving the paper machines. This is advantageous also in producing continuous output of finished paper regardless of possible interruptions in the supply of hydroelectric power which is often brought from a considerable distance.

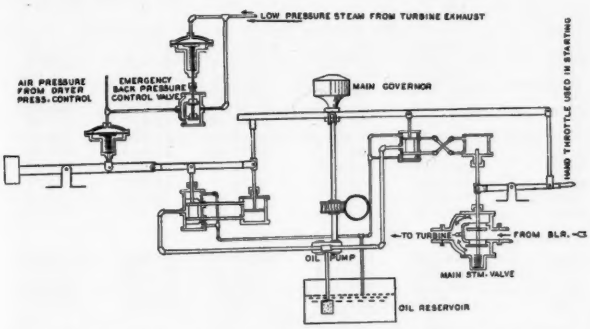


FIG. 3. DIAGRAM OF PIPING FOR REGULATOR AND TURBINE GOVERNOR

As a prime mover the steam turbine has, during recent years, largely superseded the reciprocating steam engine because it is particularly adapted for this kind of work which calls for higher back pressures and large quantities of low-pressure steam. The exhaust steam is also free from oil, an important factor in maintaining capacity.

Steam requirements are necessarily large and equivalent to approximately 42,000 lb. per hr. for a paper machine of the size mentioned above. Power obtainable, assuming that all this steam is passed through the turbine at a throttle pressure of 135 lb. per sq. in. ga. with 75 deg. F. superheat would represent approximately 1375 hp. at a back pressure of 15 lb. ga. The direct-current power required to produce 600 hp. at the paper machine is about 508 kw. This uses 732 hp. of the turbine output. The balance, or 643 hp. is available for producing alternating current from the alternator.

Selection of the most favorable method of absorbing this power has been a matter of increasing study on the part of paper mill engineers and at the present there is considerable difference in opinion regarding this question. The steam turbine has in many instances supplanted the synchronous motor to drive the direct-current generator.

Steam cost is of primary importance, so with this in view we might concern ourselves with the Hawley Pulp & Paper Co. Mill at Oregon City, Ore.

As we have seen, 42,000 lb. of low-pressure steam per hour is necessary to dry the paper. The only economical means formerly available for furnishing this steam was through a 600-hp. Corliss engine connected to a 500-kv-a. alternator, the steam consumption of the engine being approximately 17,000 lb. per hr. at 15 lb. back pressure. This represents only about 40.5 per cent of the aggregate, the remaining 25,000 lb. per hr. being made up by live steam.

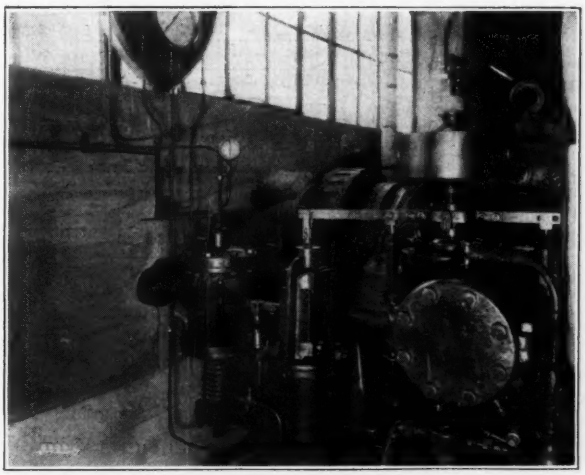


FIG. 4. CLOSE-UP OF THE PRESSURE CONTROL SHOWING CONSTRUCTION DETAILS

One dependable and reasonably satisfactory scheme considered was to connect the turbine to the motor-generator set and to control the load on the turbine by hand or motor adjustment of the turbine synchronizer spring. That is, the synchronous motor is connected in tandem with the turbine and direct-current generator. The alternator is then tied in with the hydroelectric system or other power supply and the load can be readily adjusted to supply as turbine exhaust nearly all the steam necessary for drying the paper. The exhaust represents approximately 90 per cent of the total, the remaining being live steam makeup. Without automatic control, however, this scheme has its disadvantages, insofar as the economical use of the steam is concerned.

With the above arrangement, it is necessary to arrange some satisfactory means of taking care of the steam when the paper is off the machine due to breaks and interruptions which are at times absolutely unavoidable. For such a condition the steam ordinarily is re-

leased to atmosphere but this often proves disagreeable and annoying to the paper mill employes living near the mill. As an alternative a condenser would suffice to take care of this steam but as the initial cost and the maintenance is tremendously high, it could hardly be considered as being a profitable investment, particularly when compared with another scheme described later.

A 1080-hp. synchronous motor driving a 750-kw. direct-current generator was already in use. It was decided to connect a steam turbine to this motor generator set through reduction gears and to use automatic back pressure control in connection with this turbine.

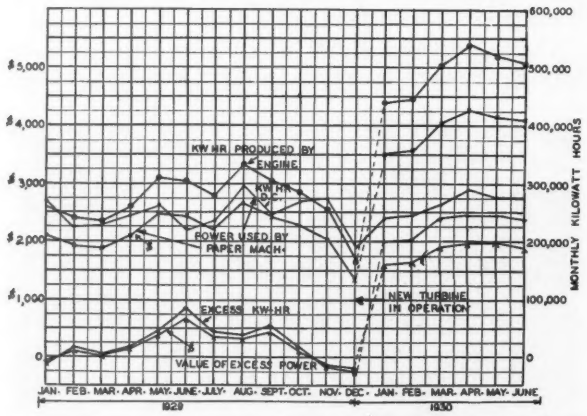


FIG. 5. GRAPHIC COMPARISON OF THE PERFORMANCE OF THE TURBINE AND ENGINE

The new turbine was a 1400-hp. Moore back pressure unit arranged in tandem with the alternating-current and the direct-current generators, the former being connected to the hydroelectric power company system. The turbine is automatically controlled in such a manner that when the paper machine is in operation and the paper is passing through to the reel, all the steam necessary for drying it passes through the turbine, no live steam being used. On the other hand, when some abnormal condition exists and the paper is not passing over the machine, little or no steam is necessary until the paper is again passing over the machine. During this off period, the alternating-current generator is temporarily the prime mover. Steam that would otherwise pass to atmosphere is automatically cut off at the turbine throttle valve, just sufficient being allowed to pass to maintain a steady pressure on the dryers during the paper-off periods.

Energy extracted from the 25,000 lb. of steam per hour, which prior to the turbine installation passed through the pressure reducing valve represents a handsome profit insofar as the alternator is furnishing power at an average rate of 420 kw. equivalent to 10,080 kw-hr. per day. This represents a net saving of $24,500 per year of 310 da. It may be said without fear of contradiction that the capital investment of $20,000 was fully warranted. The chart as shown will serve to indicate the actual performance of the Corliss engine compared with that of the steam turbine and the net savings in dollars and cents based on excess power rate of 8 mills ($0.008) as purchased.

The turbine is provided with a back pressure control which acts on the governor valve of the turbine and permits just enough steam to pass through the turbine to maintain the desired pressure in the exhaust line. Speed is maintained constant by the alternator being operated in parallel with a hydroelectric system. The speed governor of the turbine is so arranged that it will immediately take control in case speed rises above normal.

Engineers of the Hawley Pulp & Paper Co. have adapted this control to make it responsive to exhaust steam pressure at the paper machine instead of directly at the turbine exhaust opening. To accomplish this purpose, a Tycos "Singl Duty" pressure regulator has been used as a relay between the paper machine steam header and the Moore back pressure control mechanism. Compressed air is used as an operating medium and slight changes in exhaust steam pressure at the paper machine header cause proportional but greater changes in the air pressure imposed on the diaphragm of the turbine control. To provide against possible failure of the compressed air supply, arrangement has been made to apply exhaust steam directly to the diaphragm of the turbine control in the event of excessive back pressure.

This system of back pressure control has been found absolutely dependable, simple and as the setting of the back pressure is similar to turning the hands of an everyday clock, it is handled entirely by the paper makers.

Savings realized by the use of the new turbine compared with the 500-kw. engine together with other data of interest are shown by the curves and also by the tabulation. With the control used, the turbine will always produce the maximum power from the steam passing to the paper machine and never waste exhaust steam to the atmosphere.

TABULATION SHOWING THE AMOUNT AND VALUE OF POWER PRODUCED

Year and Month	Kw-hr. d.c. used by No. 4 paper machine	Kw-hr. produced	Value at $.008 per Kw.-hr.	Kw-hr. Prod. in excess of paper mach. d.c. requir.	Value of excess power at $.008 per Kw-hr.
1929		By Engine			
Jan.	270,000	258,000	$2063.00	12,000	$ 96.00
Feb.	225,000	240,000	1920.00	15,000	120.00
Mar.	230,000	235,000	1880.00	5,000	40.00
Apr.	245,000	260,000	2080.00	15,000	120.00
May	265,000	310,000	2480.00	45,000	360.00
June	220,000	305,000	2440.00	85,000	680.00
July	235,000	280,000	2240.00	45,000	360.00
Aug.	296,000	334,000	2672.00	38,000	304.00
Sept.	247,000	303,000	2425.00	56,000	448.00
Oct.	269,000	285,000	2280.00	16,000	128.00
Nov.	274,000	255,000	2040.00	19,000	152.00
Dec.	190,000	163,000	1304.00	27,000	216.00
1930		By Turbine			
Jan.	240,000	438,000	$3504.00	198,000	$1584.00
Feb.	244,000	445,000	3560.00	201,000	1608.00
Mar.	265,000	503,000	4024.00	238,000	1904.00
Apr.	290,000	534,000	4272.00	244,000	1952.00

WOUNDS HEAL very fast, if they are properly cleaned and treated. Clean means not only clean of dirt, but also clean of germs. These germs lie on the skin and often on the tool or whatever causes the wound. When germs are not cleaned out of the wound at once, there may be enough to cause blood poison. Hospital attaches say the mortality rate from lockjaw is 90 per cent. Liberal use of Mercurochrome will kill the germs and prevent infection.

Improving Plant Operation by

CONDENSER MAINTENANCE

Clean tubes, air and water leakage form important factors in successful condenser performance

RELIABLE AND CONSISTENT PERFORMANCE of condenser and auxiliary equipment is necessary for the efficient operation of the modern power plant. This performance is maintained only by refinement of design details, rigid inspection and careful interpretation of data supplied by instruments. Like so much modern power plant apparatus poor condenser performance or inefficient operation is discernible only from the operating results of the station as a whole, the equipment itself giving little or no apparent indication of either good or bad performance.

The function of the condenser is to maintain the desired vacuum with the least expenditure of power. This requires efficient, well maintained auxiliaries so piped that there are not excessive friction losses. These auxiliaries are necessary to supply a sufficient quantity of cool circulating water; adequately remove the air and non-condensable gases; remove the condensed steam from the hotwell continuously and protect the condenser against excessive pressure. A typical layout showing the principal equipment from screen house through to the last stage of the air ejector is represented by Fig. 1.

Practically all operating difficulties that may be encountered in the condenser proper lead to low vacuum and increased back pressure at the turbine exhaust. Among these are low heat transfer caused by oil, sediment, scale, debris and slime on either the steam or water side of the tubes; air leakage through joints, valve stems glands or vents and drips which should not have been connected to the vacuum system; insufficient air pump performance, caused sometimes by insufficient capacity but more often by water pockets in the air line, choking of the pump by steam entering through leaky baffles or from an overloaded condenser; insufficient or too warm circulating water or too low velocity through the tubes and sometimes; overloading caused by excessive steam flow either because the condenser is too small or an excessive amount of steam is coming through the turbine due to some mechanical or operating difficulty.

Perhaps the most important operating requirement of the condenser in the high-pressure station of today is the demand for minimum tube leakage; that is, circulating water leakage from the water side, which is usually under a slight pressure, to the steam side which is under a high vacuum. The most likely source of this leakage is around the ends of poorly packed, or through holes in split or corroded tubes.

This leakage does not affect the condenser vacuum but mixes with the condensate and is returned to the boiler. If the circulating water is the same as the boiler makeup, this leakage would be unimportant but unfortunately, especially in industrial districts, the circulating water is very hard, often containing industrial wastes which are extremely harmful to boilers. Condenser leakage is usually the controlling factor in determining the character of the boiler water when evaporated makeup is used.

Clean tubes are also necessary if high heat transfer

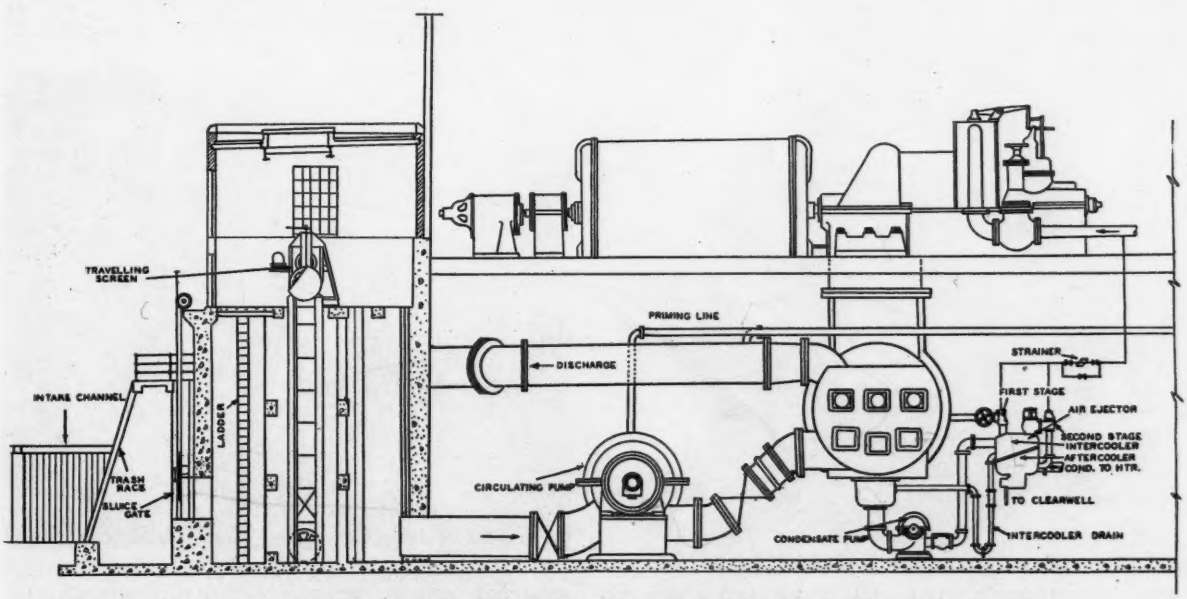


FIG. 1. TYPICAL CONDENSER LAYOUT OF THE MODERN POWER PLANT

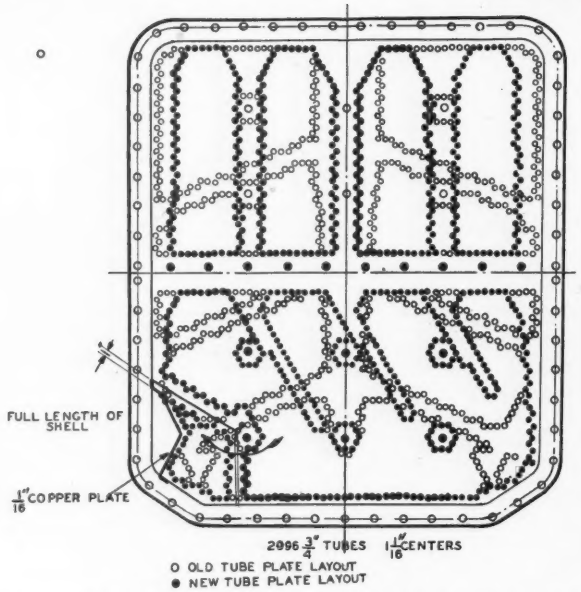


FIG. 2. REARRANGING THE TUBES IN THIS CONDENSER INCREASED THE VACUUM FROM 26 TO 28.3 IN.

and vacuum are to be maintained. Quite often scale formed by the precipitation of chemicals in the water is the offender, in certain districts leaves, sticks and mud cause the trouble while in still other districts where there is considerable sewage in the water, a slimy vegetable growth or algae forms. Deposits on the outside of tubes are less serious but by no means unknown. Chemicals carried over from the boilers and sometimes oil from auxiliaries will coat the tubes or form a slight oxide scale which decreases the heat transfer somewhat.

Air leakage is the third item of condenser operation that demands close attention. Little air enters with the steam; most of it finds its way in through joints of the condenser shell, small piping, and turbine casing. The atmospheric relief valve is a frequent source of leakage as in a well regulated plant it is seldom used and easily forgotten so that the water seal is not always maintained. Air blankets the tubes and decreases the heat transfer from steam to water and also builds up the back pressure because, according to Dalton's law of partial pressures, the total pressure is the sum of the partial pressure due to the air and that due to the steam.

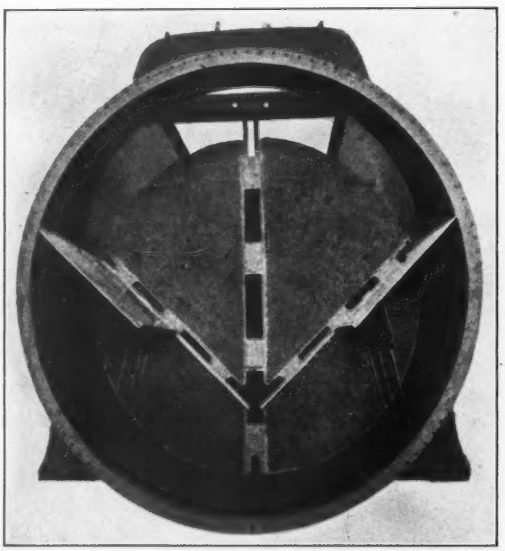


FIG. 3. CONDENSER WITH TUBE SHEET AND TUBES REMOVED TO SHOW THE SUPPORT SHEET

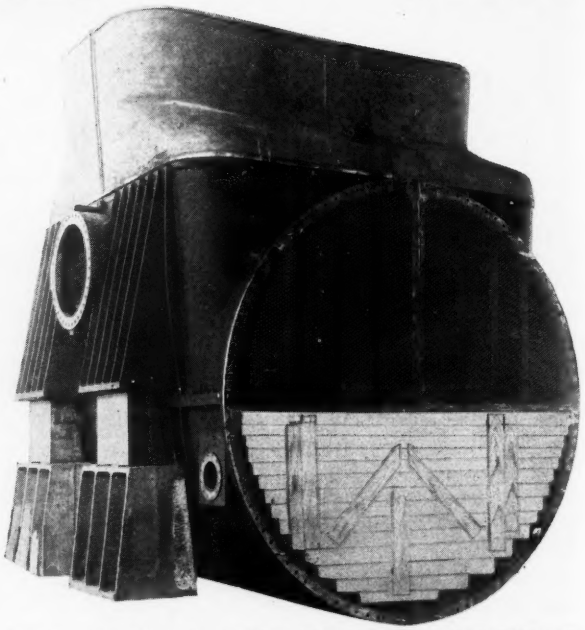


FIG. 4. CONDENSER WITH LOWER HALF READY FOR TUBING

Then there is, of course, the matter of condenser design which will not be covered in this article. A few years ago, condenser shells were packed full of tubes. These tubes were so closely spaced that the steam would not penetrate through the outer bank and many of them served no useful purpose. Modern condensers are built with steam lanes allowing the steam to penetrate to all parts of the tube bank. An example of a change of this kind where the vacuum was increased from 26 to 28.3 in. is shown in Fig. 2.[1]

When we consider tube leakage, tube failures due to

[1]See "Improving Condenser Performance," by V. E. Johnson, p. 1055, Oct. 1, 1929.

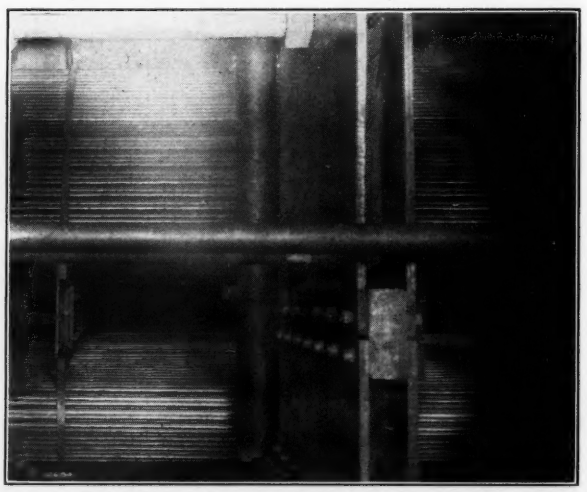


FIG. 5. LOOKING DOWN INTO A TUBED CONDENSER SHOWING TUBES, SUPPORT PLATES, BRACES AND THROUGH BOLTS

splitting, erosion, corrosion and electrolysis[2] cannot be neglected. It is necessary to obviate this difficulty as nearly as possible by judicious and experimental selection of materials to meet local conditions. Condenser leakage meters[3] are of assistance in detecting leakage and can be used to advantage especially in high-pressure plants using bad condensing water.

Of course not all tube failures are caused by these troubles. Many of them are purely mechanical, caused, perhaps, by impingement of moisture particles at high

FIG. 6. TUBE GUIDE SOMETIMES USED WHEN PLACING TUBES IN CONDENSERS

velocity on the tubes or sometimes chafing and vibration of the tubes in the support sheet. Auxiliary exhausts which are sometimes used to take the exhaust from steam-driven auxiliaries frequently give trouble by a combination of erosion and corrosion caused by steam impingement.

Such inlets should be fitted with a baffle or deflector upon which the steam impinges. A case of local erosion was recently corrected at Lakeside Station in an interesting way. Ribs in the exhaust hood of the turbine and baffles above the condenser support sheet concentrated the steam upon certain sections and caused erosion. A roof-like structure of subway grating was made and installed in the exhaust hood base above the condenser. The slanting position of the grating dissipated the kinetic energy of the high velocity moisture and was effective in correcting the trouble.

Many of the large condensers have tubes 20 ft. or more in length, so great, in fact, that deflection of the tube would occur of its own weight even without the

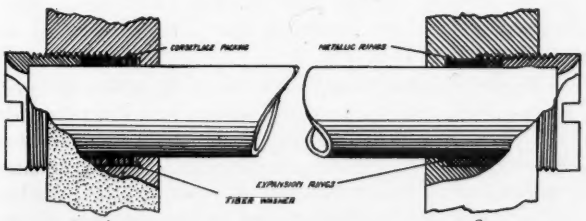


FIG. 7. TUBE PACKED WITH CORSET LACE (A) AND METALLIC PACKING (B)

added weight of the circulating water. In this case, the tube must be supported by one or more plates known as support plates, usually made of cast iron. In addition to supporting the tubes, these plates maintain the alinement and are so placed that there is a slight upward bow in the middle of the tube to provide drainage for the tube when the water boxes are emptied.

Holes in these plates should be machined accurately with about $\frac{1}{16}$-in. clearance and slightly chamfered so that they will not damage the tube. The plates themselves should be placed so that they do not interfere with the longitudinal distribution of the steam. A support plate installed in a condenser under erection is shown in Fig. 3, the side baffles coming down to a V in the center are placed there for the double purpose of collecting the condensate from the tubes above from the air cooler section tubes and to force the air and noncondensable gases down through the condenser and up through the tube bundle underneath the baffle. In this type of condenser, the air outlet to the vacuum pump is well up on the side of the shell near the angle formed by the baffle and shell.

When tubing an entire condenser, it is best, if possible, to remove the condenser cover and water box completely and build a wooden cover as indicated in the lower half of the condenser in Fig. 4. For convenience

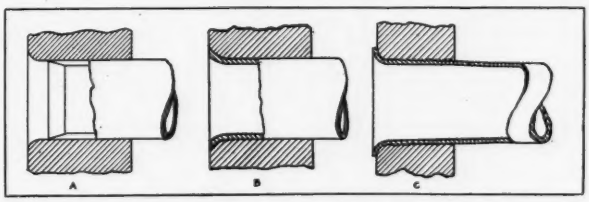


FIG. 8. TUBES ROLLED OR EXPANDED INTO THE TUBE SHEET

and ease of handling, this should be made of finished, first quality lumber without knot holes. Either 6 or 8-in. boards can be used and to prevent warping and still not have the weight excessive, 1 in. thickness is satisfactory.

For small condensers, the entire head can be covered but for large condensers it is best to tube the lower half

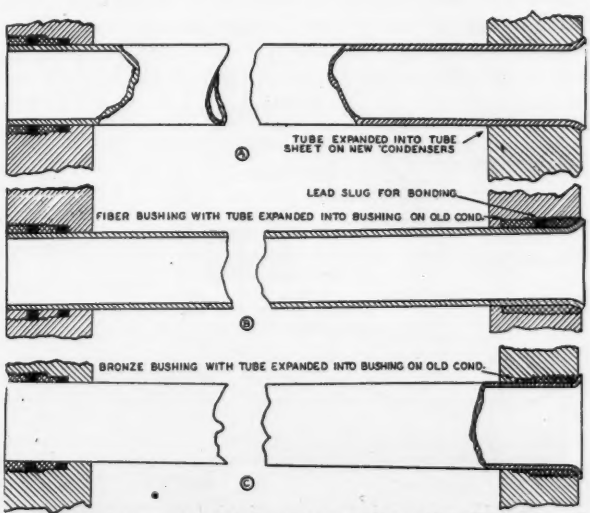

TUBE EXPANDED INTO TUBE SHEET ON NEW CONDENSERS
LEAD SLUG FOR BONDING
FIBER BUSHING WITH TUBE EXPANDED INTO BUSHING ON OLD COND.
BRONZE BUSHING WITH TUBE EXPANDED INTO BUSHING ON OLD COND.
A
B
C

FIG. 9. TUBES PACKED AT ONE END AND ROLLED AT THE OTHER, NO FERRULES USED

first, the cover can then be reversed and used on the upper half while the lower half is being packed. Tubes should be handled carefully, preferably being left in the shipping box and taken out only as used. If piled too deep or left around on the floor, it is almost impossible to avoid damaging them. They should be picked up by two men to avoid bending. One man should be inside the shell at each support plate and at the other tube sheet to guide the tube through the proper hole. Tubing should begin at one well defined corner and the tube

[2]See "Tube Failures in Surface Condensers Increase Maintenance," p. 893, Aug. 15, 1929.

[3]See A.S.M.E. Power Test Code, Instruments & Apparatus, Part 21, Chapter I, on Condenser Leakage Tests.

sheet pattern should be filled in a regular manner so that those inside the shell will have no difficulty in placing the tube accurately and quickly. A tube guide of a design somewhat along the lines shown in Fig. 6 is sometimes used to facilitate tubing small condensers, or sections not easily reached. This guide simply consists of a piece of metal, of the same diameter as the outside of the tube, pointed on one end and turned down to the inside diameter of the tube at the other end. The spring is not absolutely necessary. The guide should be as light as possible.

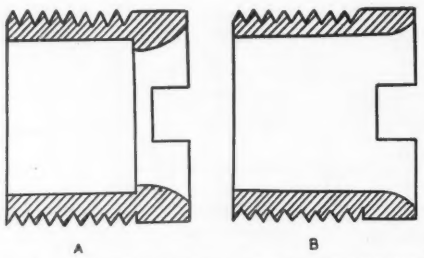


FIG. 10. TYPES OF FERRULES, A, WITH SHOULDER, USED WHEN BOTH ENDS ARE PACKED, B, WITHOUT SHOULDER, USED WHEN ONE END IS ROLLED

When replacement of one or more tubes after the condenser has been in service is necessary, the work will be greatly facilitated by running a piece of small pipe of suitable length in the tube before it is withdrawn. The pipe is left in place and serves as a guide for the new tube.

Until quite recently, practically all tubes were packed at both ends as shown in Fig. 7, the tube being free to expand and contract within certain limits determined by shoulders on the ferrules. The tube length,

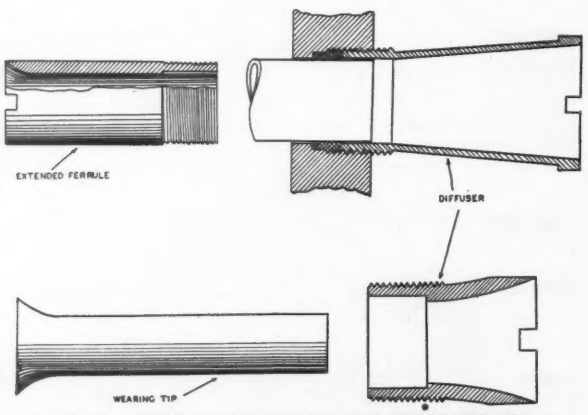


FIG. 11. SPECIAL FERRULES AND WEARING TIPS

packing, ferrule and stuffing box must be so proportioned that with the tube snug against the shoulder of one ferrule, the other end of the tube will still be in the other ferrule. Otherwise expansion and contraction may lead to pinching of the packing between the tube and ferrule, causing leaks and crushing of the end of the tube.

Common types of packing used are corset lace, hose, fibre and metallic packing. The first is a cotton braid or string cut the desired length and sometimes treated with linseed oil or paraffine; the second is a cotton braid similar to the cotton covering on a hose and is braided the proper diameter and cut the right length to fill the stuffing box; fibre packing is a short cylinder of fibre moulded to diameter and cut the right length to fill the stuffing box while the last or metallic packing consists of metallic rings.

Figure 7 shows a tube packed in one end with corset lace, packed on the other with metallic packing. Fibre or lead rings are used on each side of the corset lace and asbestos or fibre expansion rings with the metallic packing.

Increasingly bad circulating water, higher boiler pressures and the desire to cut down turbulence of the water entering the tubes, led to increased use of tubes rolled or expanded into the tube sheet somewhat after the method shown in Fig. 8. Sometimes the tube is rolled at one end and packed at the other as in Fig. 9, while sometimes where the water is unusually bad the tubes are rolled at both ends. Some condenser designs have fixed tube sheets and expansion of the tubes is taken up by bowing the tubes. In other designs, an expansion joint is provided sometimes in the shell, sometimes in the head itself to allow a slight movement and give a floating tube sheet.

It is, of course, quite evident that when rolled at one end the tube is held in place and with suitable packing no ferrule is necessary on the other end. Metallic packing answers this purpose nicely but with some other type of packing, for instance corset lacing, a ferrule must be used. This, as a rule, is of the type shown in Fig. 10B.

It is customary to have the water enter the tube at the rolled end so that in a two-pass condenser the first pass tubes will be rolled at one end of the shell and the second pass at the other end of the shell. That is, half the tubes of each end will be packed and the other half rolled. In order to allow expanding the tubes in tube sheets already drilled for ferrules, bushings either bronze or fibre are available and can be installed as shown by B or C of Fig. 9.

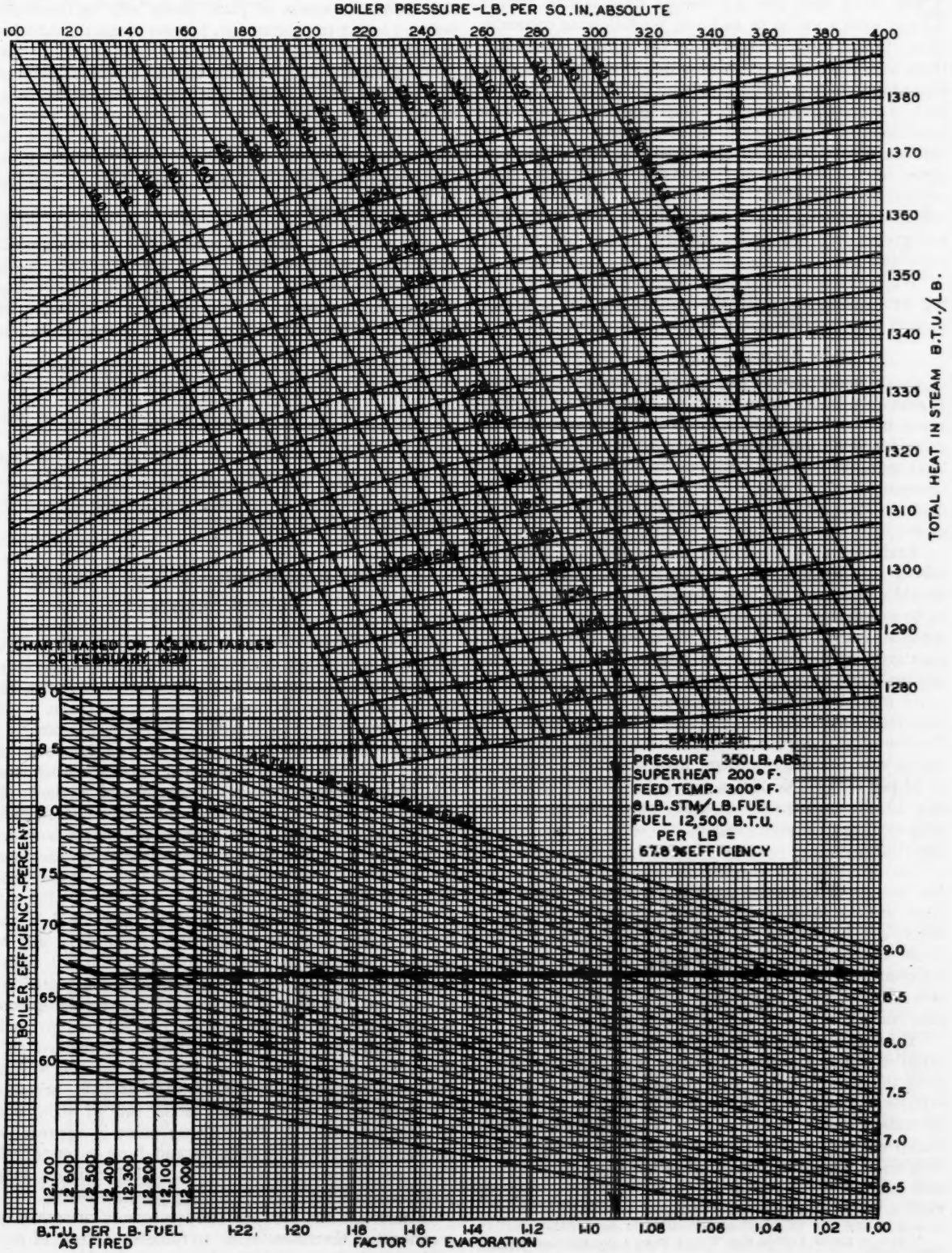
Experience has shown that, especially where ferrules are used, air bubbles tend to collect along the tube just inside the entrance and cause corrosion. To obviate this difficulty, special ferrules are sometimes used and many companies find that a wearing tip or short belled section of tubing 4 to 6 in. long placed in the entrance of the tube increases the tube life appreciably. Both ferrules and wearing tips are shown in Fig. 11.

Graphic Calculation of Boiler Efficiency

CHART DESIGNED FOR QUICK SOLUTION OF BOILER OPERATING DATA. BY E. F. BAILEY

TO USE THE CHART, start at the top at the pressure carried (in pounds absolute), drop vertically to intersection of given degrees of superheat, cross horizontally from this point to intersection with given feedwater temperature, drop vertically from this point to find factor of evaporation. From the point where the last vertical line crosses the actual evaporation per

pound of fuel, cross horizontally to given B.t.u. value of fuel per pound, then follow angle line to get boiler efficiency. The example shown is run with heavy lines to illustrate the method. If it is desired to get the equivalent evaporation per pound of fuel, cross from intersection at actual evaporation, horizontally, to figures on lower right-hand corner. This performs the desired multiplication.



Power Interchange Economics

COMMERCIAL ASPECTS AS BETWEEN UTILITIES AND LARGE INDUSTRIALS.* BY GEORGE E. WHITEWELL**

FOR SUCCESS over a period of time, lasting results and profits are to be had only by following economic laws. Conservation of energy by the utilities, the industrials and other interests is essential to secure maximum advantage, hence utilities should enter into relations with industrial concerns in a way to meet the economic conditions of today, not those of yesterday when competition was less keen. Today it is recognized that, with large heat-producing or heat-using industrials, both utility and industrial should study the problem of energy interchange, both parties being absolutely frank and giving each other all necessary facts as to costs and other factors.

When this is done, it is a relatively simple engineering problem to ascertain the best method of interconnection and interchange of power.

HEAT SAVING FOR A STEEL PLANT

In the modern steel plant a great amount of energy is available in the form of waste heat and combustible gases, much of which may go to waste because of noncoincidence of heat and power requirements. With interchange, the utility's facilities can absorb energy when necessary and, at other times, supply power to the industrial, thus giving a heat balance approximating that of the most up-to-date power plant.

Each case must be studied as an individual problem, taking into account all the special circumstances, and should show profit to both parties if interconnection is to be satisfactory. No simple formula can be given because so many factors are involved and this is a comparatively new phase of the power problem for both utilities and industrials.

In one instance, interchange of 15,000 kw. of power involved expenditure of $300,000 for a 25 to 60-cycle frequency changer and $125,000 for extension of the utility's transmission system, involving a fixed charge, at 13 per cent of $55,250 a year. The utility has available 15,000 kw. capacity at unity power factor and the steel company has spare capacity to serve as standby for the utility.

As the utility increases its capacity in blocks to care for two or three years growth, there is available for from one to three years considerable surplus energy, which can be sold to the steel company without additional investment. Cost of energy is such that, with safeguards for changes in the price of coal, it is profitable for the utility to purchase the steel company's surplus energy up to the limit of the interconnection.

Three classes of service are recognized: Emergency, supplied either way for unforeseen requirements; dump, from the steel company surplus to the utility; surplus, supplied either way for considerable periods under agreement made previously to starting the supply. Dump energy of 30,000,000 kw-hr. a year during week ends and nights and representing approximately 50 per cent load factor is bought by the utility at a price to yield a profit and pay fixed charges.

*From a paper before the World Power Conference, Berlin, June, 1930.

**Vice President, Duquesne Light Co., Pittsburgh, Pa.

Conditions to be considered as reviewed from a paper presented before the Association of Edison Illuminating Companies by Messrs. Hirshfeld, Elliott and Walker are:

Large demand for process steam at such pressure that power in excess of plant needs may be developed before passing to process use; process steam demand less than for power with good load factor and plenty of condensing water; large amount of waste heat a temperature high enough for economical steam generation; large amount of combustible waste material such as wood or gas; large power needs at good load factor with fuel and condensing water at competitive prices; water power site near industrial plant with excess firm or seasonal power.

In considering amortizement of investment, stable conditions for the future as well as the present must be assured. Investment required in special plant may be protected by selling it outright to the industry; by leasing to the industry, or the industry installing, the utility to operate; by renting to the industry in its own plant; or by joint ownership.

Rates will be determined by the amount of power or other service sold by either party to the other, taking into account surplus available, maximum demand, load factor and power factor.

To repeat, interconnection and power interchange between utilities and industrial plants should be based on sound economic advantage to both and deserve the best thought of their executives.

Determinination of Ash Fusing Temperature.

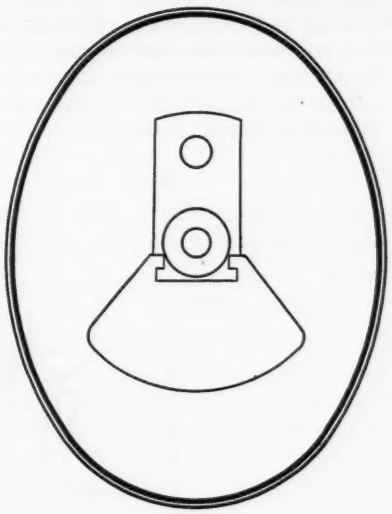
IMPROVED boiler room operation and the desire for higher boiler ratings has raised the furnace temperature considerably during the last few years and given the fusing temperature of ash increased importance.

All engineers are familiar with the dangers and troubles of this low temperature fusing ash but not many are familiar with the method of determining what this fusing temperature is. A number of methods are available, the latest being by means of an electrically heated strip of metal. The most common way, however, is to make a small pyramid or cone-shaped piece and put it into a furnace with a number of other cones whose melting point is known.

To prepare the sample, about ⅛ lb. of coal is pulverized and heated in air until only the gray ash remains. This ash is then ground until it all passes through a 200-mesh screen after which it is heated for an hour at 1560 deg. F. to burn off the remaining combustile. The ash is then molded into a small pyramid ¾ in. high and ¼ in. at the bottom and molded on a base. The cone is heated in a gas-fired furnace with an excess of gas and with air supplied at 3 lb. pressure. The temperature is increased at the rate of about 5 or 10 deg. per min. As the melting point is approached, the cones bend over or collapse and form a round ball. The temperature at which this ball formation takes place is considered as the fusing temperature.

Sometimes the furnace temperature is measured by a calibrated thermometer or pyrometer instead of comparing with cones whose melting point is known.

DIESEL ENGINE UPKEEP



PART VI. CRANKSHAFT REPAIR METHODS. METHOD OF REMOVING LOWER BOXES WITHOUT TAKING OUT SHAFT. EFFECTS OF MISALINEMENT. DESCRIPTION OF VARIOUS METHODS FOR CHECKING CRANKSHAFT ALINEMENT

CRANKSHAFT FAILURE is so destructive that Diesel engine designers have taken every precaution in selection and treatment of material and in design of parts to avoid fracture which, in the early designs, was so frequent. A crankshaft is inherently a weak structure and in a Diesel engine any faulty setting of the spray valve which would cause it to open too early or any improper operation of the valve may cause preignition and throw exceedingly heavy loads upon the shaft.

MISALINEMENT IS FREQUENT CAUSE OF FAILURE

Another cause of crankshaft failure is misalinement of the main bearings which results generally from unequal wear in the main bearings supporting the shaft and occasionally from unequal settling of the foundation.

Failure usually occurs through fracture of the web, the cracks starting at the center and gradually working out. Either web may fail in a single cylinder unit but with two-cylinder units, numbering the webs consecutively from the end farthest removed from the flywheel, web No. 4 fails most frequently. With three-cylinder units, the fracture occurs most commonly in webs 1 or 6 and with four-cylinder units, usually web 4 is the one that fails.

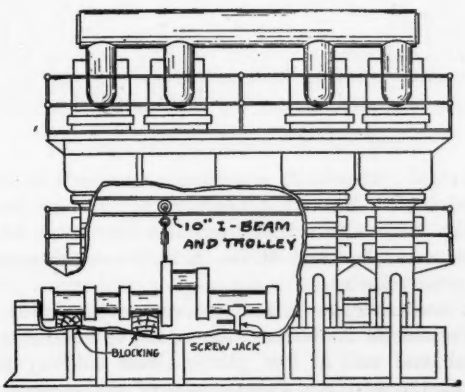


FIG. 1. LONGITUDINAL CROSS SECTION OF ENGINE SHOWING METHOD OF BLOCKING UP CRANKSHAFT

Strains set up by torsional vibration may also cause crankshaft failure. With a single cylinder, the flywheel of an engine will always be slightly ahead of the crank on the compression stroke and slightly behind it on the power stroke. With multiple cylinders there will be a periodic fluctuation of stress for every power impulse. Every shaft has a natural period of vibration. If the frequency of the power impulses coincide with this natural period, excessive vibration will be set up. This is called the critical speed of the shaft and can be avoided by changing the speed of the engine.

Fracture from torsional vibration occasionally occurs in one of the journals which breaks at approximately 45 deg., the principal crack frequently passing through the oil hole; other cracks at right angles will likewise pass through the oil hole. If the fillets are very small, the break is likely to occur between the pin and web. The more liberal fillets now used on Diesel crankshafts have reduced danger from this source to a minimum.

Other possible causes for failure are improper design, defective material and improper heat treatment of engine parts during construction. Whatever the primary cause may be, the shaft does not break off suddenly but is first gradually weakened by fatigue or crystallization.

FLAW DETECTION

Small cracks which may develop should be inspected promptly for depth by building up a dam of putty or red lead around them and filling the cup thus formed with kerosene oil which is then allowed to stand for several hours. After the putty and oil have been removed and the crack wiped thoroughly dry with a clean cloth, a piece of thin white tissue paper is placed over the crack and the journal is given a heavy blow with a lead maul. If the crack is deep, the paper will be well soaked with oil but if the crack is only at the surface, no oil will show on the paper.

Crack development should be looked for whenever the shaft is inspected or checked for alinement. The best method of shaft removal depends upon the design of the engine. A convenient method by the use of chain blocks, trolley and an I-beam fastened within the engine frame is illustrated in Figs. 1 and 2. As shown, the

shaft when lifted should be supported upon wooden blocking and short pieces of timber or bagging may be used to protect the shaft against possible marring during removal. The necessity for proper location of dowel hole in the crankshaft and the weakening effect of an improperly located dowel hole are illustrated in Fig. 3.

Repair Methods

In repairing such a shaft by the shrunk-on band method, the first step is to see that the ouside contour of

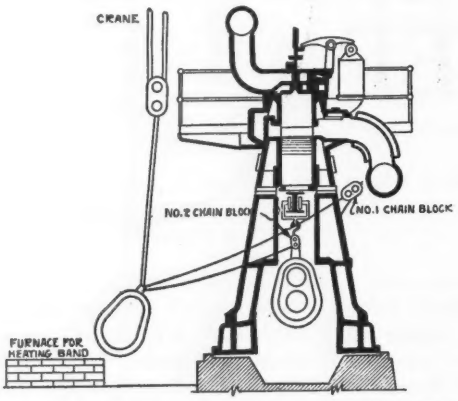


FIG. 2. CROSS SECTION OF ENGINE SHOWING LOCATION OF I-BEAM AND CHAIN BLOCKS

the web is trued up. A template of wooden sections to fit the outside of the web is then made, after which a sheet-iron template to fit this wooden form is cut out allowing for shrinkage of the band by making it sufficiently smaller. The shrinkage amounts allowed for the shaft illustrated are shown in Fig. 3 to be 0.03 in. in the larger and 0.013 in. in the smaller dimensions. These amounts were obtained by multiplying the dimensions A

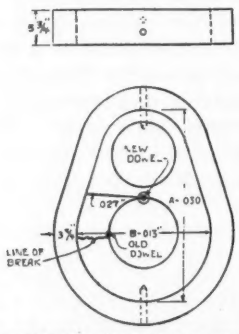


FIG. 3. BROKEN CRANKSHAFT WITH SHRUNK-ON STEEL BAND SHOWING LOCATION OF CRACK DETERMINED BY DOWEL HOLE AND PROPER LOCATION OF DOWEL

and B by the elongation coefficient and adding an allowance for roughness and, in the case of A, for the crack in the web.

Allowing 30,000 lb. per sq. in. and subtracting 10,000 lb. per sq. in. for shrinkage limit, we have 20,000 lb. per sq. in. tension. Taking 60 per cent of this tension, we have 12,000 lb. per sq. in. safe working stress. Since the net sectional area is $5.75 \times 3.875 = 22$ sq. in., the total working stress will be $22 \times 12{,}000 = 264{,}000$ lb. As the distance from the center of the shaft to the gravity axis of the band section is 13.25 in., the allowable moment on the crankshaft will be $264{,}000 \times 13.25 = 3{,}498{,}000$ in.-lb. At half stroke, the allowable cylinder load will be $3{,}498{,}000 \div 13 = 268{,}461$ lb. This being a 4-cylinder engine, two cranks will give, therefore, a total of 536,922 lb. thrust, or with a piston area of 406.5 sq. in. the equivalent pressure in the cylinder that the band would resist safely at half stroke would be $536{,}922 \div 406.5 = 1320$ lb. per sq. in.

Then the band is forged of steel to correspond to the sheet-iron template, heated uniformly to redness in the temporary furnace built alongside of the engine, slipped over the web and allowed to cool slowly. When the shaft is placed into position, two pins indicated in dots at the top and bottom of the web, Fig. 3, are put in to prevent the web from moving sideways in case it failed to hold the load.

Welding Repair Methods

Autogenous welding, which is now so generally available for reliable repairs, offers a ready means for repairing crankshafts. If the shaft has not been broken through, the crack must first be machined or otherwise

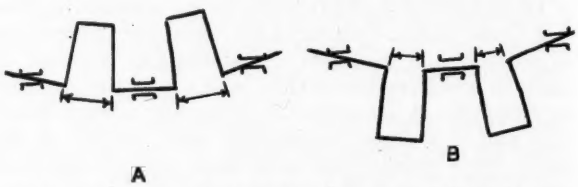


FIG. 4. LOW CENTER BEARING CAUSES REVERSED BENDING ACTION. A—UPPER DEAD CENTER POSITION. B—LOWER DEAD CENTER POSITION

cut out to the bottom of the fracture as previously explained in welding operation and the weld must be gradually built up as described. Thermit welding lends itself well to crankshaft repair. In any case, after proper preparation, the shaft must be set up on blocks on the floor, carefully lined up and thoroughly clamped in position before the welding operation is started. In order to be assured of reliable results, welding of this kind should be done by experts.

It is important that main bearings be kept in perfect alinement. If for any reason one or more of the bearings are lowered, the span between the bearings actually supporting the shaft will be increased, throwing heavy stresses on the crank arms, which, if allowed to continue, will ultimately cause the shaft to break. The manner in which a low center bearing produces reverse bending in the shaft and alternate spreading and contraction of the crank webs is illustrated diagrammatically in Fig. 4. This also indicates how such bending localizes the bearing pressure, causing increased wear and how excessive pressure is applied to bearing caps under this condition.

Checking Crankshaft Alinement

Several methods of checking crankshaft alinement are available. The main bearing caps can be removed and the lower shells rolled out one at a time and the thickness of the shell at the bottom can be measured with a micrometer.

In each case, it is best to measure the thickness in three places on the bottom; one near the middle and one at each end and at two places about halfway up the sides in the middle. Comparison of the various thicknesses will show how much the several bearings are worn

down; therefore, how much the shaft alinement has been affected.

Rolling out the lower bearing, where grooves have been cut in the shell, may be conveniently performed as illustrated in Fig. 5. Such grooves are of such a depth that a wire may be slipped around the shell in each groove and fastened at one end to a bar as shown, after which the shell may be turned around by pulling the unfastened ends.

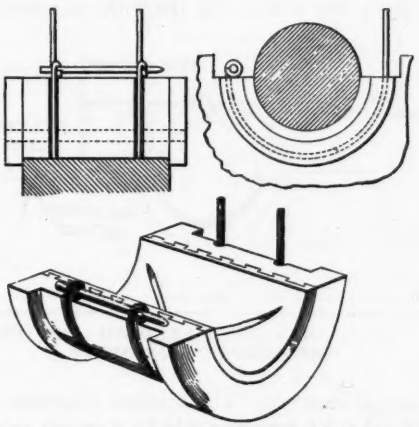


FIG. 5. CONVENIENT METHOD OF ROLLING OUT LOWER BEARING

If the bearing shell is not provided with these grooves, it may be easily removed by means of a tool, A, Fig. 6, which is hooked over the end of the shell. The engine is then barred over slowly until the crank web engages the shoulder of the tool at, B, and the opposite end of the bearing tapped in the same direction to prevent binding. The shell will then roll out as the shaft is turned.

After taking the caps off and before removing the shells, it is well to give the upper half of each shaft journal a light coat of thin red lead and, as the shaft is slowly turned over, put on more red lead until the journals are covered. Then, by turning the shaft a couple of revolutions, it will be easy to see whether the shaft is supported in all the bearings also whether the shaft itself is true. Prussian-blue may also be used to indicate points of contact.

If the shaft is not exactly true at any bearing, the journal will show a bearing on one side and nothing on the other. If the shaft is true and supported in the bearings, the journal will show a bearing all around. If the shaft is approximately true but gets no support in the bearing, the journal will show that it has not touched during the entire revolution.

Alinement by Use of Fixed Points

If any journal shows that the shaft is not exactly true at a certain point, the amount that it is out of true can be checked as follows: Roll this shell out, then measure down with a micrometer from some fixed point in the frame above the shaft to the shaft journal, getting this measurement while the nearest crankpin is at its upper and lower center also when this crankpin is halfway down and halfway up. These measurements will show at once just how much the journal may be out of true.

When fixed points can be arranged above each journal, the alinement of the bearing can be checked as follows: Loosen all main bearing caps and shim them up so they do not touch the shaft. Then measure down from some fixed point with a micrometer to the top of each journal through the oil hole in the top of the main bearing cap. Now put a piece of cardboard between each main bearing cap and shaft and draw the shaft down solid with the nuts of the bearing caps. Again measure the distance from the fixed point above each journal down to the journal and improper support and the amount the bearing shell is low will be readily observed.

Checking Spread of Crank Web

Another method of checking crankshaft alinement, which does not require the removal of the shaft, is to measure the spread and contraction of the distances between the crank webs as shown in Fig. 7. To do this, the crankpin is first brought to its upper dead center and the shaft forced into the bearings with jacks. Micrometric measurement is then made of the distance between two reference points on the crank webs and noted. The crankpin is then brought to its lower dead center and the shaft forced down again into its bearings

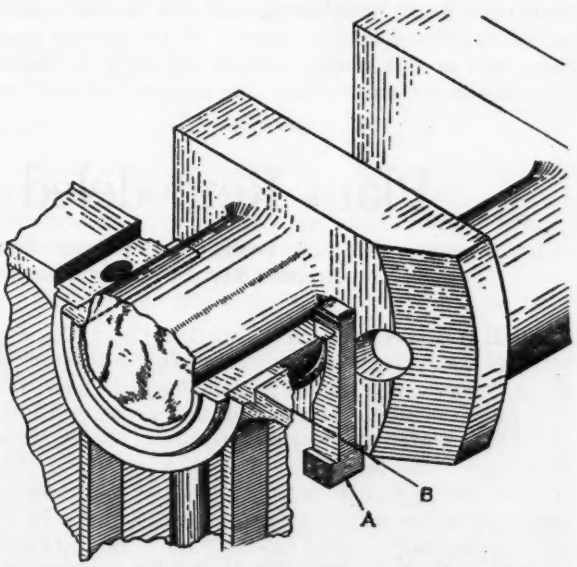


FIG. 6. METHOD OF ROLLING OUT BEARING BY USE OF TOOL WHICH CONNECTS IT TEMPORARILY WITH SHAFT

and measurement made as before between the same reference points on the crank webs.

When the alinement is perfect, both measurements will check. If the first measurement is larger than the second, the bearing on one or both sides of the crank is low and should be corrected. If the second measurement is the larger, the bearing on one or both sides is high in comparison with the others and the cause should be located and corrected.

Dial Indicator as a Check

Crankshaft alinement may be checked by means of a dial indicator as illustrated in Fig. 8. After forcing the shaft into its bearings as before, place the dial indicator on the machined surface of the engine frame which surface must be thoroughly cleaned, and is perpendicular

to a vertical line through the cylinders. Then adjust the length of the indicator rod so that the indicator rests on the top of the shaft as shown. Now, starting at one of the end main bearings, move the indicator back and forth until the top of the shaft is located, which will be

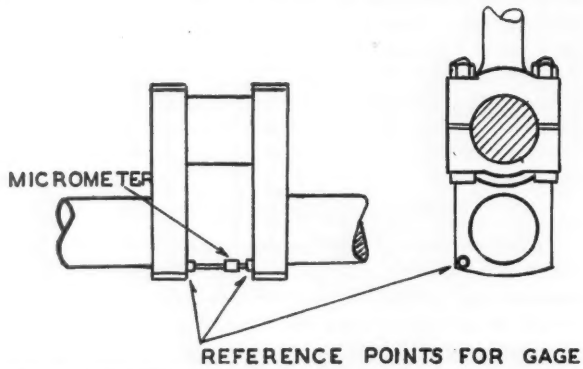


FIG. 7. CHECKING CRANKSHAFT ALINEMENT BY MEASURING THE SPREAD AND CONTRACTION OF THE DISTANCES BETWEEN THE CRANK WEBS

when the pointer of the indicator comes to rest, after which the dial should be moved until it registers zero. Then move to the next bearing and find the high point on the shaft in a similar manner. If the pointer goes above zero in this second position, the shaft is higher here than at the end bearing. The number indicated on the dial shows the amount of difference in thousandths of an inch.

Bridge gages, which are now furnished by some manufacturers with their engines, are useful in indicating a general misalinement in relation to the engine bed but they will not show whether or not the bed has been sprung. This is a condition, however, which is so uncommon that it can almost be neglected. The only safe way to know how a shaft lies in its bearings is to check it. The bridge gage is useful for this purpose, since it requires only a few minutes to check the alinement every

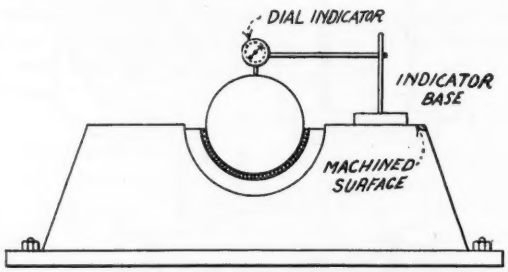


FIG. 8. DIAL INDICATOR AS USED FOR CHECKING CRANKSHAFT ALINEMENT

time a cap is removed. The original clearance between the gage and the journals should be stamped or engraved on the metal of the gage so that the record cannot be destroyed.

Plant Remodeled Increases Economy

NEW POWER PLANT WITH COMPLETE SYSTEM FOR CONTROL AND RECORDS SAVES FUEL AND INCREASES PRODUCTION. BY L. A. CORWIN*

SOME YEARS ago, the Milwaukee Chair Co., for over half a century makers of fine quality office chairs, began a program of remodeling throughout the power plant and mills to secure greater economy. Today the old time worn return tubular 150-hp. boilers, three in number, have been replaced with a modern setting of two 300-hp. cross drum type water-tube boilers, served by an up-to-date stoker equipment with a 10 ft. 6 in. setting above grates, to enable the burning in suspension of sawdust refuse, which is spouted directly to the boilers, excess air being taken care of by induction of steam to the spouts.

One boiler only is operated at all times, at approximately 150 to 175 per cent of rating, furnaces being designed as to requirements to burn only coal efficiently and economically, refuse to be taken into consideration as a matter of disposal only.

Coal is handled from the cars by a conveyor to a live hopper of a silo type storage system. When this hopper is filled to its capacity, coal overflows to the silo proper in dead storage capacity, being reclaimed by an elevator from the lowest point of the silo to the live storage bin, Fig. 1.

Coal passes from the live storage hopper by a chute to a weighing larry, whence it is taken by a spiral conveyor to the stoker hoppers. The boiler operator has only to push an electric control button to start the system in operation or to stop it.

As there is an enormous demand for process steam for the lumber kilns, varnish dry kilns, bending room dry houses and glue limes, the exhaust from the prime movers is entirely absorbed, while at night live steam is furnished for these operations. Average steam delivery per hour is around 11,000 lb. per hour in normal weather, increasing to 18,000 lb. per hour in sub-zero conditions.

Power is generated by one 150-kw. Westinghouse generator, Fig. 2, direct connected to a 22 by-36 in. Murray Corliss engine and a 75-kw. generator, direct connected to a Chuse high-speed non-releasing valve gear unit. The switchboard consists of two generator panels, one exciter panel and four feeder panels with four outgoing circuits of 500,000 circular mils capacity to one bank of cabinets, and another circuit of 300,000 circular mils capacity to a lighting cabinet. Electrical equipment has been provided throughout the plant for higher speed machines by frequency changers.

In order to create greater efficiency on night loads of steam consumption and to increase kiln capacity, Foxboro controls were installed, after much experimental work and rebuilding of kiln design, with a net result of 25 per cent increase in kiln production at a 16 per cent saving of fuel.

*Chief Engineer, The Milwaukee Chair Co.

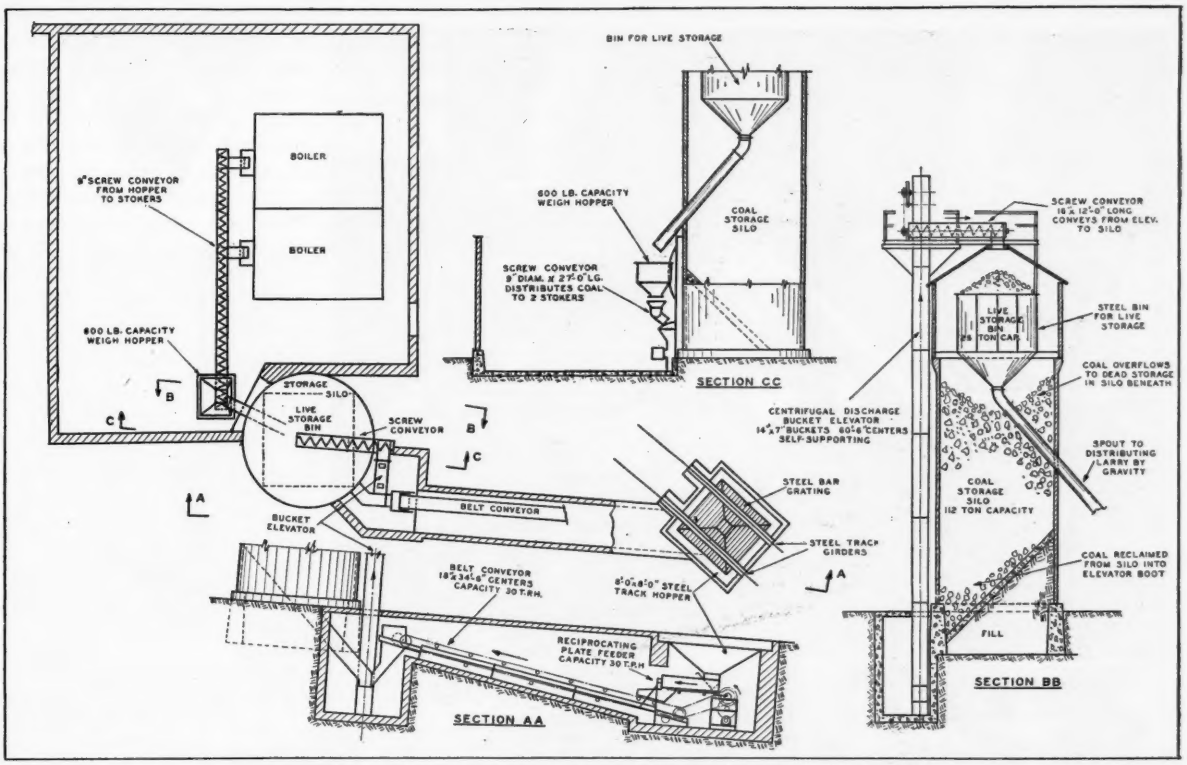

BIN FOR LIVE STORAGE
BOILER
BOILER
8" SCREW CONVEYOR FROM HOPPER TO STOKERS
600 LB. CAPACITY WEIGH HOPPER
600 LB. CAPACITY WEIGH HOPPER
COAL STORAGE SILO
SCREW CONVEYOR 9" DIAM. X 27'-0" LG. DISTRIBUTES COAL TO 2 STOKERS
SECTION CC
SCREW CONVEYOR 18" X 12'-0" LONG CONVEYS FROM ELEV. TO SILO
STEEL BIN FOR LIVE STORAGE
LIVE STORAGE BIN 25 TON CAP.
COAL OVERFLOWS TO DEAD STORAGE IN SILO BENEATH
STORAGE SILO
LIVE STORAGE BIN
SCREW CONVEYOR
CENTRIFUGAL DISCHARGE BUCKET ELEVATOR 14"x7" BUCKETS 60"-6" CENTERS SELF-SUPPORTING
SPOUT TO DISTRIBUTING LARRY BY GRAVITY
STEEL BAR GRATING
BELT CONVEYOR
COAL STORAGE SILO 112 TON CAPACITY
BUCKET ELEVATOR
STEEL TRACK GIRDERS
BELT CONVEYOR 18"x34'-6" CENTERS CAPACITY 30 T.P.H.
8'-0"x8'-0" STEEL TRACK HOPPER
COAL RECLAIMED FROM SILO INTO ELEVATOR BOOT
RECIPROCATING PLATE FEEDER CAPACITY 30 T.P.H.
FILL
SECTION AA
SECTION BB

FIG. 1. COAL GOES TO SILO STORAGE THENCE TO STOKER HOPPERS

Instruments of the latest type and pattern are being provided for departmental check-ups on power consumption. Air, for varnishing and chair assembly requirements is delivered by two 90-cu. ft. compressors, one being under automatic control in the capacity of a booster, for air demands at certain load periods.

Many adverse conditions were met while under construction in this remodeling period but, during the entire time that the boilers were being installed and the removal of the old equipment in both engine and boiler room, not one hour was lost.

The first operation to be performed was to make

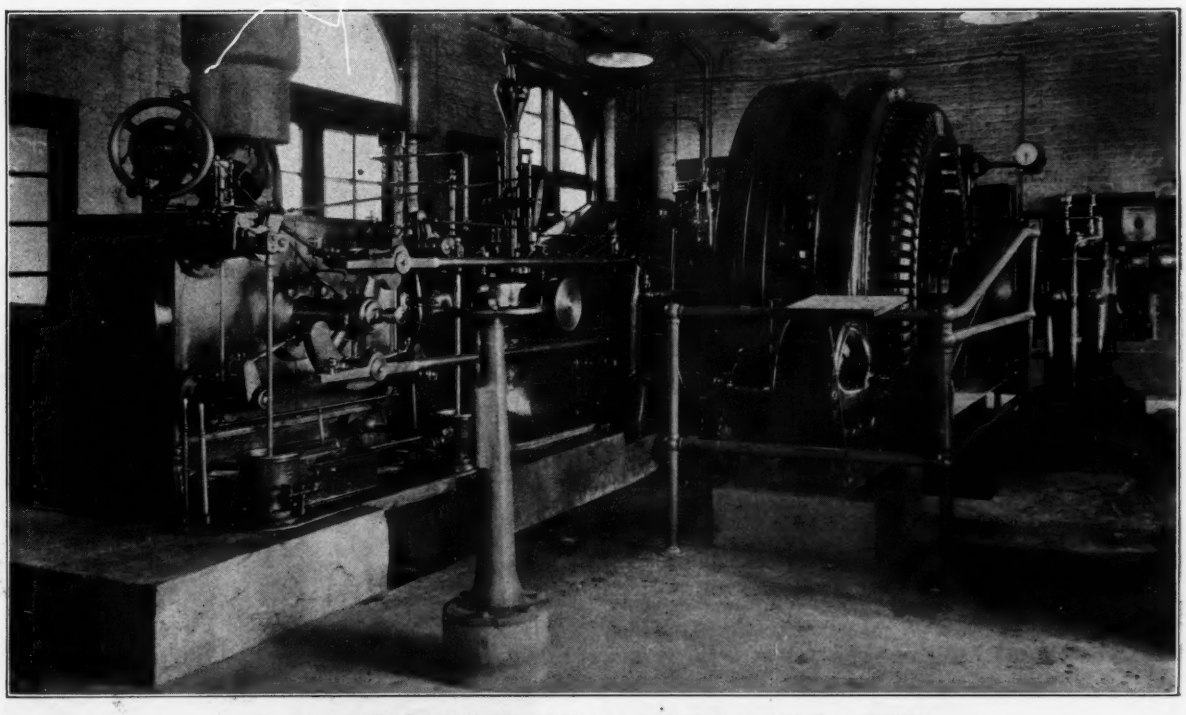


FIG. 2. MAIN GENERATING UNIT IS DRIVEN BY CORLISS ENGINE

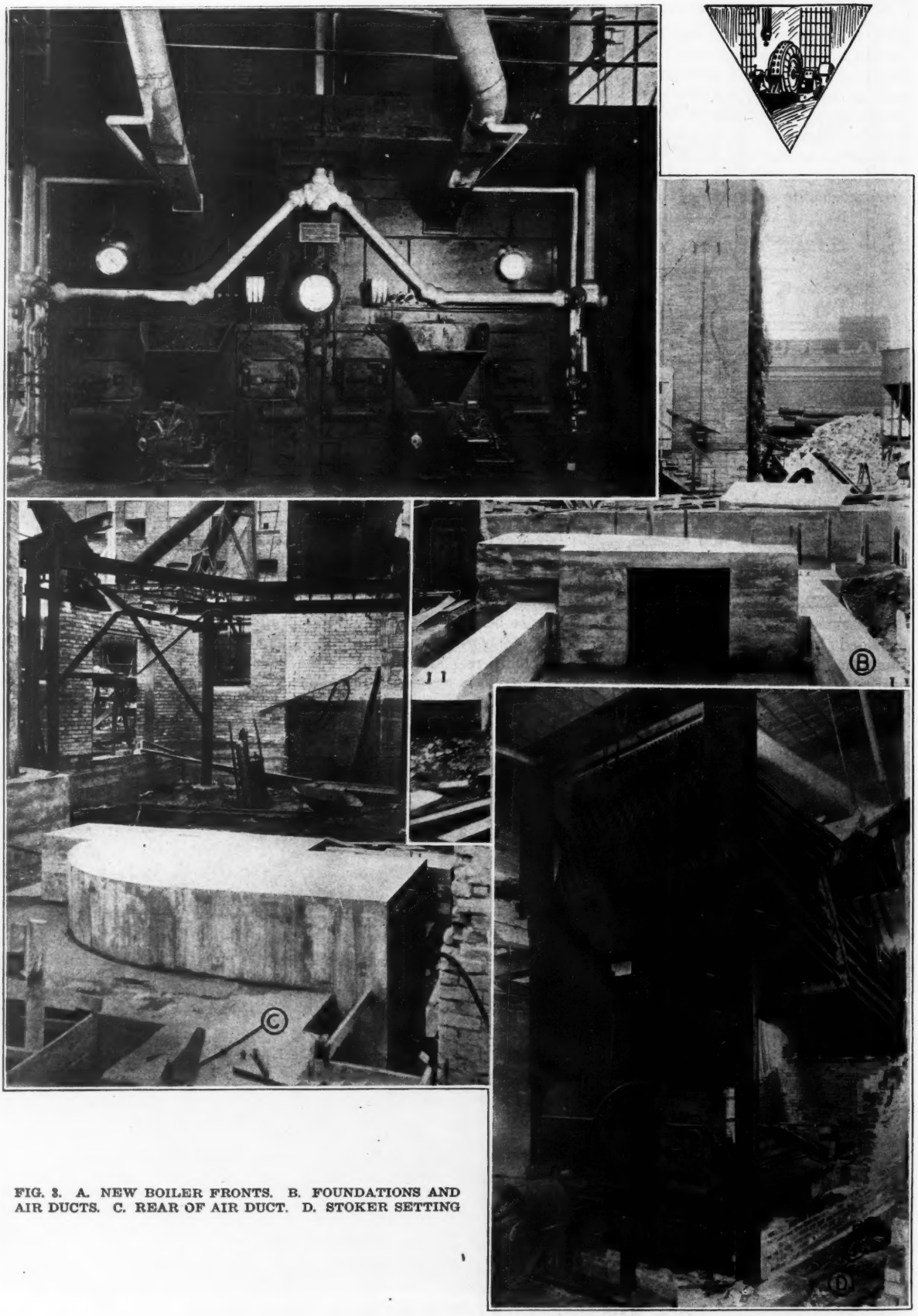


FIG. 8. A. NEW BOILER FRONTS. B. FOUNDATIONS AND AIR DUCTS. C. REAR OF AIR DUCT. D. STOKER SETTING

space for the installation of the new boiler which required the removal of one 150-hp. return tubular boiler and a portion of the building. Over-time was applied in order to remove this boiler and the main header and to disconnect auxiliary piping. The hardest part of this removal of the boilers was the fact that the girders, primarily used for the suspension of these boilers, were laid into the building walls and not set on columns, as is general practice. The building walls in question were in bad shape, having deteriorated during a period of

In the meanwhile, during the erection of this boiler, a survey was made of the building, to increase both its floor space and height. Another condition that existed at that time was the support of an enormous cyclone, in weight about 18 t., that had to be supported on top of the old roofline and old building walls.

This was done by properly guying the top portion of this cyclone to the adjacent building and then removing one of the leg supports projecting this section into mid-air, until the building construction of that portion

THE MILWAUKEE CHAIR CO.

POWER PLANT LOG

WEATHER_____

TEMP._____ DATE_____ 19____

Time A. M.	No. 1 GEN. Volts	Amp.	K. W.	No. 2 GEN. Volts	Amp.	K. W.	T. M. E. R. & L. Volts	Amp.	K. W.	No. 1 ENG. Started	Stopped	No. 2 ENG. Started	Stopped	Time P. M.	T. M. E. R. & L. Started	Stopped
7:00														6:00		
7:30														6:30		
8:00														7:00		
6:30														5:30		
7:00														6:00		
														6:30		
														7:00		

No. 1 BOILER Start.	Stop.	Opr.	No. 2 BOILER Start.	Stop.	Opr.	No. 3 BOILER Start.	Stop.	Opr.

Coal Consumed—Days

Coal Consumed—Nights

Coal Consumed—Shifts 1 2 3

Total Coal Consumed

Total K. W. Output

Oil Used Eng. Room Eng. Oil Cyl. Oil

Oil Used Boiler Room Eng. Oil Cyl. Oil

Packing Used Waste Used

Repairs Made

Shift No. 1			Shift No. 2			Shift No. 3	
Fireman			Fireman			Fireman	
No. 1 BOILER			No. 2 BOILER			No. 3 BOILER	
	Fires	Water	Fires	Water		Fires	Water
1							
2							
3							

KILNS OPERATING

Report—Accidents—Delays

Operating Engr.

Asst. Chief Engr. Chief Engr.

FIG. 4. POWER AND FUEL ARE FULLY RECORDED

years from both weather and conditions surrounding the boiler room, so that when the final underground portion of the old foundations had been removed, the building walls were left unsafe and columns had to be applied beneath the suspension girder. The outer wall, facing a busy thoroughfare, had to be replaced and anchored with cables on the boiler settings to hold them in position for continued daily operation.

After the first boiler site had been prepared, new boiler foundations were installed, air ducts placed and the boiler erected, Fig. 3.

of the roof had been so arranged that this supporting leg could be anchored on to the girder from a point of the roof supports. Prior to the anchoring of this cyclone, it was necessary to raise a 60-ft. gin pole from the ground to a point directly beneath the unsupported portion of the cyclone so as to give proper support. Then the cables from this one section that had been holding it in mid air, were removed and the operation was reversed to the other side. After the structural steel work was completed, the main support of this cyclone was anchored to the girders.

One peculiar feature of the entire boiler construction work was that the old stack breeching, which had served its purpose over a period of 21 yr. and maintained itself during the first part of the construction work, collapsed on the day that the new boiler was cut in for service. Had this occurred just one hour earlier, the plant would have been shut down. The entire construction of the building was completed prior to the installation of the first boiler and, in fact, housed the old boilers up to the time that they were removed.

Forced draft air for the new boilers was taken from a small Clarage fan and piped through a 10-in. duct with baffles installed in the new air ducts so that sufficient air could be had to operate the new boiler until the second unit had been installed with all the latest equipment.

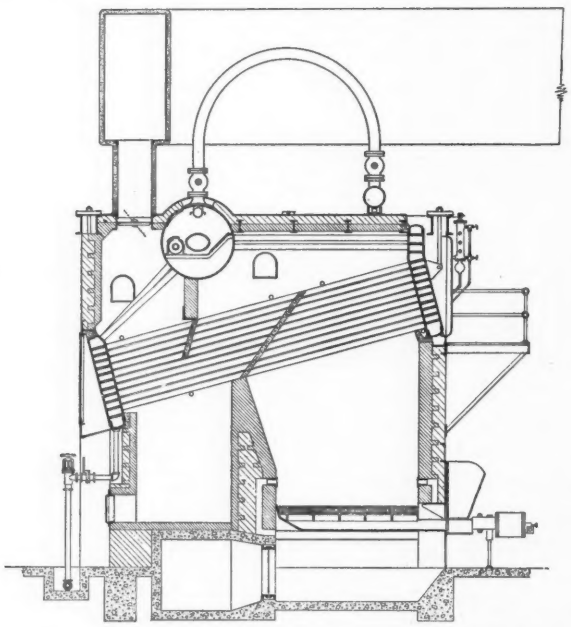


FIG. 5. FURNACE CAPACITY IS AMPLY PROVIDED

Naturally, there were several periods when we had insufficient air and were just about able to carry the boiler load. Removing of the old equipment and the installation of new was completed in a period of a little less than ten months from the time of starting without serious accidents or casualties to any of the employes, during the erecting to a point of final operation.

Complete records are kept as to coal and water consumption, regulation of steam, steam consumption to kiln, steam consumption by process work and steam consumption by prime movers.

Power plant log sheets, Fig. 4, are kept in the fullest detail, with monthly records checked so that actual costs of lumber as dried, coal burned and kilowatts generated can be applied against chairs shipped. Temperature of feedwater and temperatures of the returns from the heating system are also kept in chart form, so that a complete chain is effected in the entire operation.

Saving that has been effected by these changes is 25 per cent on fuel alone. Labor costs are, of course, reduced primarily and permanently. Where the former cost per kilowatt, as purchased, averaged 3½c per kw-hr., efficient operation and the remodeling of this plant has produced a kw-hr. for 0.8 cent.

Heating costs were reduced by replacing heating coils with a modern unit system and also securing better humidity control.

Boiler design, Fig. 5, was by James A. Clay of the Freeman Mfg. Co., all arrangements and construction being under consultation of the chief engineer of the plant. Equipment installed is as follows:

EQUIPMENT AS FURNISHED TO MILWAUKEE CHAIR CO. PLANT

2 300-hp. boilers, water-tube, type C, Freeman Mfg. Co., Racine, Wis.
Stoker equipment, S. R., Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.
Boiler feed pumps, American Steam Pump Co., Battle Creek, Mich.
Valves, Lunkenheimer Co., Cincinnati, Ohio.
Bends and headers, George B. Limbert Co., Chicago, Ill.
Draft gages, CO_2 recorders, Hays Instrument Co., Chicago, Ill.
Steam flow meters, Cochrane Co., Philadelphia, Pa.
Draft control, Cash Co., Decatur, Ill.
Fans and fan engines, Clarage Fan Co., Kalamazoo, Mich.
Sawdust disposal, Alfred C. Goethel Co., Milwaukee, Wis.
Pipe covering, Fred Sprinkman & Sons, Milwaukee, Wis.
Coal handling equipment, Stephens-Adamson Mfg. Co., Aurora, Ill.
General equipment, Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.
Corliss engines, Murray Iron Works, Burlington, Iowa.
Chuse engine, Chuse Engine Works, Mattoon, Ill.
Switchboard, General Electric Co., Schenectady, N. Y.
Kiln equipment, Foxboro Co., Foxboro, Mass.
Plant building construction, E. C. Knuth Co., Milwaukee, Wis.
Boiler brick work, and erection, E. A. Reese Co., Milwaukee, Wis.
Electrical work, Dietz Electric Co., Milwaukee, Wis.
General piping, Geo. A. Portz Co., Milwaukee, Wis.
Steel work, Worden-Allen Co., Milwaukee, Wis.
Boiler design, Jas. A. Clay, Freeman Mfg. Co.
Consulting-Supervision, L. A. Corwin, Chief Engineer, The Milwaukee Chair Co.

SURFACE CONDENSERS are usually favored in modern power plants because the condensed steam is recovered and serves as pure feedwater demanded by high boiler ratings and high pressures. As a rule, water available for cooling is satisfactory but occasions do arise where the acid condition of the water is such that corrosion prohibits its use. Trade wastes in industrial centers are sometimes bad and mine water invariably so.

Mine water pumped for drainage purposes is often available for condenser water without further pumping and in many cases is the only supply around. Barometric condensers work in this scheme very well, because the condenser and tail pipe can be lined with wood to prevent corrosion. Power saved for circulating water pumping and the elimination of the need for providing a supply of non-corrosive water will more than pay for the loss of condensate.

The Industrial Switchboard of Today

By ALFRED C. FINNEY
Switchgear Department,
General Electric Co.
Philadelphia, Pa.

IN ORDER THAT the power generated in a modern plant may be properly controlled and distributed, it is necessary to interpose between the generators and the load or distribution system, some sort of switching equipment. This equipment, throughout the years, has gradually evolved into the multiple panel switchboard as we know it today.

The purpose of the switchboard is three-fold: First, it is a means of control for all generating and distribution circuits; second, it protects these circuits against abnormal conditions; and third, it gives information on the output and efficient operation of the plant. To avoid confusion, the switchboard is usually divided into a number of panels, each controlling an individual circuit, or the circuits may be otherwise distinguished—for example, by keeping all the equipment in a vertical row. In any case, provision must be made for these three fundamental functions, switching, protection and metering.

Let us look at a typical switchboard as outlined in Fig. 1 and see what equipment is needed to carry out these functions. As an example, this has been assumed to control the following circuits:

One a.c. generator, 3-phase, 3-wire, 2300-v., 1500-kv-a. with direct-connected exciter.

One a.c. generator, 3-phase, 3-wire, 2300-v., 4000-kv-a. with direct-connected exciter.

One 3-phase, 3-wire, 2300/115-v., 30-kv-a. station service transformer bank.

Two motor generators consisting of 2300-v., 500-kv-a. synchronous motor and 250-v., 400-kw., d.c. generator.

Six 2300-v., 300-amp., a.c. feeders.

Four 250-v., 1200-amp., d.c. feeders.

Material of panels for mounting the control equipment depends largely on a matter of choice between oiled natural black slate and ebony asbestos compound, with steel also to be recommended for the a.c. or dead-front sections of the board. Steel has the advantage of lightness and strength, making easy handling of complete panels in one section. Framework and fittings as well as finish have been worked out to allow good matching of steel panels in one part of the board with other panels of slate or ebony asbestos where needed for mounting knife switches and air circuit breakers.

Size and Form of Panels

As to size of panels, Fig. 1 shows a commonly standardized height, 90 in. The general progress in design has been toward increasing compactness, reducing the width to a minimum without overcrowding. This has been facilitated by improvements in design of apparatus, a notable example being the rectangular types of instruments and meters, which make the most complete use of the panel space occupied. The length of the switchboard is usually dependent on the oil circuit breakers used, if these are mounted directly back of the panels. If the breakers are remote mounted and particularly if they are electrically operated, greater advantage may be taken of economies in space occupied by the panel mounted equipment, with resulting increased compactness and convenience to the operator.

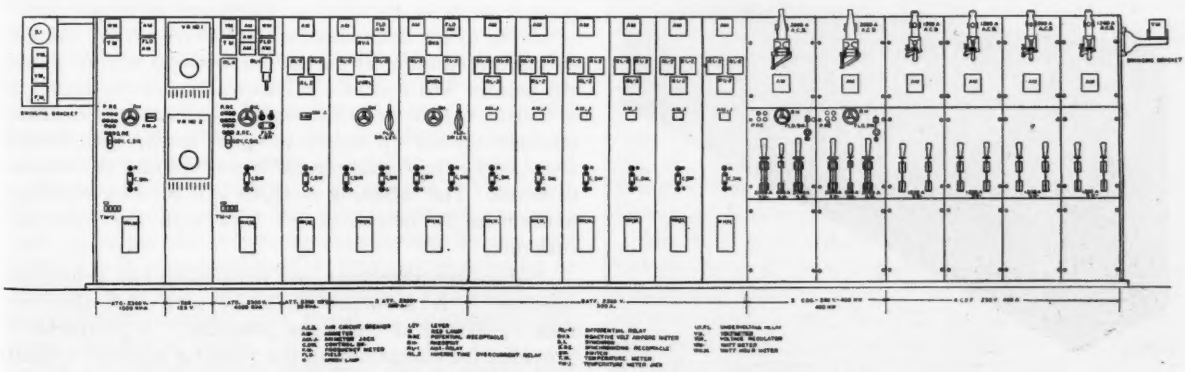


FIG. 1. FRONT LAYOUT OF A MODERN SWITCHBOARD

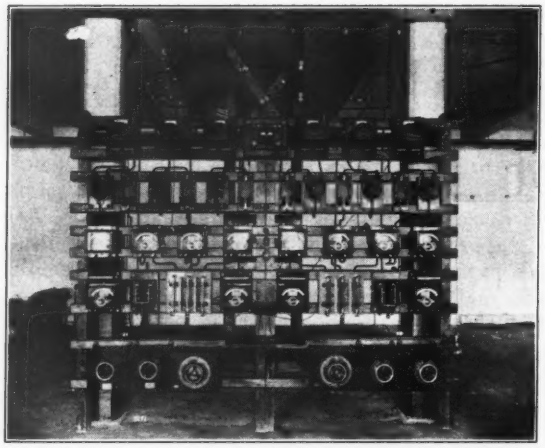


FIG. 2. EARLY SKELETON SWITCHBOARD

Several other forms of mounting for switching equipment are available, such as pedestals, pillars, cubicles, benchboards, truck type and metal clad equipment. Some examples are seen in Figs. 4, 5, 6 and 7. Each of these forms has its advantages for various operating conditions and surroundings. The safety enclosed equipment shown in Fig. 4 is particularly well adapted to individual motor control in the plant. But the switchboard shown in Fig. 1 will illustrate the usual equipment required.

In the arrangement of panels for various circuits, it is customary to make allowance as far as practicable for future extensions. Thus circuits not likely to increase in number such as totalizing, station auxiliaries, etc., are kept near the center of the board. Generator circuits may then be extended by additional panels in one direction, and feeders in the other direction. Where some definite plan can be made for the future, blank panels for circuits expected may be installed. These will later be replaced by completely equipped panels or drilled for mounting the equipment. Where extensions to both a.c. and d.c. switchboards are probable it is well to keep them as separate boards. This may also allow more convenient arrangement of buses, connections, and cables.

Instruments

The generator equipments outlined in Fig. 1 will be sufficient to take care of usual conditions. For indicating the load on the machine we have the a.c. ammeter, showing that part of the load responsible *for heating of windings,* and the wattmeter to indicate the *mechanical load imposed on the engine or turbine.* Ammeter jacks are used to check the current on various phases or 3 ammeters without transfer may be used if desired. A further improvement is a triplex ammeter with some saving in space over three separate ammeters. The d.c. field ammeter gives a measure of the heating of the field and exciter and shows the proper setting of rheostats. A watthour meter is also desirable as a record of power turned out.

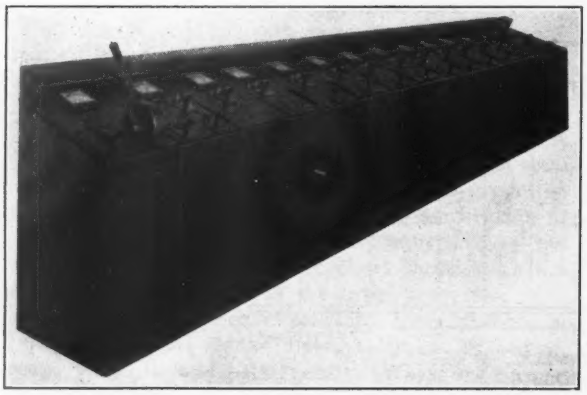


FIG. 3. STEEL BENCHBOARD FOR STEEL MILL

One of the most useful instruments in a generator equipment is the temperature meter. A common form of this is a direct-current instrument having two windings balanced against each other, one winding connected in series with a standard resistor and the other winding in series with a resistance detector coil embedded in the generator winding slots. This is ordinarily available only for the larger machines. With increase in temperature the resistance of the detector coil increases, while the standard resistor remains unchanged, and the amount of unbalance on the instrument is calibrated in deg. C. A number of detector coils is usually installed in each generator, but it is generally considered sufficient to connect three of these to the switchboard where they may be switched in turn to the one temperature meter. Four transfer jacks are indicated for this purpose, one being for a checking or test resistor, to check the proper action of the needle. A continuous indication may be obtained with an instrument of this type.

Common instrument equipment for several generators may be mounted on a swinging bracket as shown at the end of the switchboard. Plug receptacles or other types of transfer switches are then used to connect the instruments to any of the generator circuits.

The synchroscope is required in paralleling a.c. generators to make sure that they are not only running at the same speed but also in the same phase position before closing the breaker to connect them together. The synchroscope is constructed in the form of a small synchronous motor, the field of which is a stationary winding but alternating in effect due to connection to the machine already running. The armature has a divided winding connected through resistance and reactance to the machine being started so as to produce a rotating field. The armature then tends to assume a position where the two fields coincide when the alternating field passes through its maximum, causing the armature and pointer to move forward or backward at a rate corresponding to the difference in frequency. When the machines are running at the same frequency and in phase, the pointer will rest at a marked point on the scale. It is usual practice in synchronizing to have the incoming machine coming up slowly in speed rather than falling away at the time synchronism is reached and the breaker is closed. The incoming machine will then have enough momentum to take over its load with the least disturbance.

Before synchronizing and connecting two generators together it is necessary to make sure that they are both operating at the same potential. A voltmeter is provided for connection to the running machine and another voltmeter is usually connected in parallel with

one side of the synchroscope to read the potential of the incoming machine. This gives a good check with the two voltmeters mounted closely adjacent on the swinging bracket.

In bringing the generator up to speed, it is desirable to know the frequency of the first generator and also of any later generators so as to bring them up to approximate full speed before cutting in the synchroscope. A frequency meter will take care of this and in normal operation will assist in holding proper frequency for the plant. This instrument is most generally useful with a scale range of about 10 cycles, but may be obtained in standard designs with a range as low as two cycles.

The instruments mentioned are those most essential in showing the proper operation and loading of the a.c. generators. A power factor meter is also desirable in many cases to indicate when the current taken by the load of the plant is becoming too far out of phase with

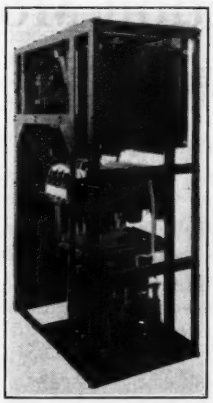


FIG. 4. SAFETY ENCLOSED STATIONARY TYPE PANEL FOR A.C. MOTOR EQUIPMENT, BACK VIEW

the potential. By transferring this instrument to various feeder circuits, the section of the load responsible for poor power factor may be located and investigated.

Another important element in the control of a generator is a regulator to hold constant voltage. This is of considerable importance in some industries. The most common form is the vibrating type holding a balance between a.c. potential and a d.c. magnet energized by the d.c. exciter potential. The exciter field rheostat or a portion of it is intermittently short-circuited, the frequency of these short circuits being greater when the a.c. potential is low, with consequent increase in exciter voltage. With the smaller machines, several exciters and generators may be controlled from one regulator. It is becoming common practice, however, especially for larger generators with direct-connected exciters, to use an individual regulator for each generator. An equalizer rheostat in each exciter field and not short-circuited by the regulator gives one means of holding uniform loads on the two or more generators in parallel. The latest method, however, where individual exciters are provided, is to connect a current transformer 90 deg. out of phase to the potential used so that any circulating or exchange currents between generators will affect the compensating winding and result in adjustment for proper division of loads.

The generator voltage regulator for a single generator, or for several small generators and exciters, may be mounted on brackets at the end of the board, but where individual units are involved the regulators are more conveniently mounted on panels. In the smaller sizes, two may be mounted one above the other on one panel within reach for adjustment. But in the larger sizes, a complete panel for each regulator is usually required and makes more convenient location next to its corresponding generator panel.

(To be continued)

N. E. L. A. Appoints Section Chairmen

CHAIRMEN of the four national sections of the National Electric Light Association for the administrative year 1930-1931 have been appointed by President W. A. Jones. They are: Accounting Section, Franklyn Heydecke, Public Service Electric & Gas Co. of New Jersey, who succeeds W. R. Emerson, Oklahoma Gas & Electric Co.; Commercial Section, T. O. Kennedy, Ohio Public Service Co., who succeeds Marshall E. Sampsell, Illinois Public Service Co.; Engineering Section, Alex D. Bailey, Commonwealth Edison Co., reappointed; Public Relations Section, Harry Reid, National Electric Power Co., reappointed.

Mr. Heydecke, the new chairman of the Accounting National Section, is general auditor, Electric Department, Public Service Electric & Gas Co. and of Public Service Corporation of New Jersey.

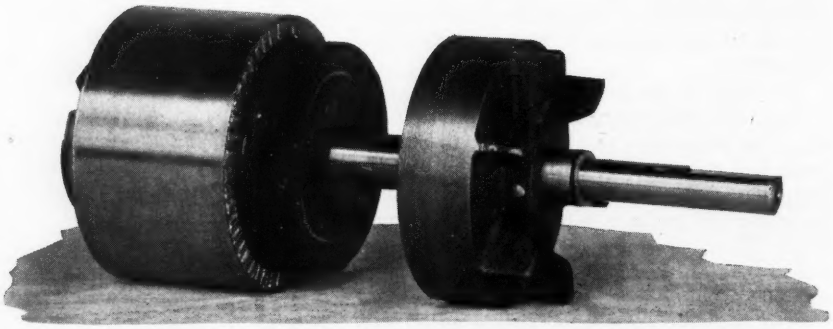
Mr. Kennedy, new chairman of the Commercial National Section, is vice-president and general manager of the Ohio Public Service Co.

Mr. Bailey, chairman of the Engineering National Section, was born in Wisconsin in 1882, and has lived in Chicago since the age of seven. After graduating from Lewis Institute (Chicago), he worked for a short time for the Evanston Heating Co. and entered the employ of the Chicago Edison Co., (a predecessor of the Commonwealth Edison Co.) late in 1903, as mechanical engineer at the Harrison Street Station.

After 3 yr. at Harrison Street Station, he was transferred to the Engineering Department of the company, where he spent the next 2 yr. planning general engineering work. In 1906, he was sent to Fisk Street Station as assistant chief engineer and, later, became chief engineer of this station. On January 1, 1921, he was appointed superintendent of generating stations of the Commonwealth Edison Co., which position he now holds.

Mr. Bailey is the author of numerous articles on the electric utility industry. Among the committees on which he has served are: Of the Commonwealth Edison Co., chairman, generating station; accident prevention; trail board; advisory; engineering; labor efficiency; 60-cycle system power factor; central safety; construction. Of the N.E.L.A., vice-chairman of the Engineering National Section; Counsellor of the Prime Movers Committee. Of the American Association of Mechanical Engineers, Main Research Committee.

Mr. Reid, chairman of the Public Relations National Section, was a prominent figure in public utility circles in Kentucky and the Middle West for 20 yr., although a native of New York. In 1917, he was elected to the presidency of the Interstate Public Service Co. In 1927, he became president of the National Electric Power Co.



Rotor of new motor showing clutch and bell

New Single Phase Clutch Type Induction Motor

By H. D. Else *

MANY LOADS WHICH require relatively small torque to carry them at operating speed, are subject to overload or starting conditions where torque considerably in excess of the normal value is necessary. In applying electric motors to light drives, this condition is frequently met by using motors of heavier rating than is necessary for the normal operating condition. The use of a clutching mechanism between the motor and the driven member is not new, but has been subject to fairly limited application, largely on account of the rather complicated construction of the operating mechanisms and on account of the lack of a suitable material for the friction members of the clutch.

Recently, the Westinghouse Electric & Manufacturing Co. placed on the market a new design of clutch motor involving certain features which have not previously been obtainable. The accompanying cut shows the construction of this mechanism. The clutch is built into the motor and the application of the unit to the drive is the same as with an ordinary motor.

*Small Motor Engineering Dept., Westinghouse Electric and Manufacturing Co., East Springfield, Mass.

FIG. 1. NEW CLUTCH TYPE INDUCTION MOTOR

The clutch mechanism consists of very few parts and these are simple and rugged in construction. A cast-iron bell with integral fan for ventilating the motor is fastened rigidly to the shaft. The rotor is free to turn on the shaft and is fitted with three pins parallel to the shaft and extending beyond the rotor at one end. Three segments engage these pins by notches in their edges. Two garter springs fitted into annular recesses in the segments control their inward and outward movement. Facings of special friction material are attached to the outer surfaces of the segments. In operation, a very small movement of these segments outward brings the faced surfaces into contact with the bore of the bell.

In starting an ordinary load, this clutch operates in much the same manner as a sliding type of clutch. The shaft remains stationary until the rotor, which is turning on the shaft, reaches approximately ¾ of full load speed. At this point, the centrifugal force of the segments overcomes the resistance of the garter springs and the segments move into engagement with the bell and accelerate the load to operating speed.

If the starting resistance of the load is too great for the motor to bring it up to speed on initial engagement of the clutch, the rotor of the motor decelerates to approximately half of full load speed. At this point, the tension of the garter springs is sufficient to cause the clutch weights to release. The rotor then accelerates to the point where the clutch weights engage and the operation is repeated, the impulses increasing in intensity to a maximum of approximately six times the rated torque of the motor.

A similar cycle is set up in case of a pull-out due to overload in operation.

This peculiar type of operation is obtained by taking advantage of the change in coefficient of friction between the segment facings and the clutch bell with change in temperature. With increase in coefficient of friction, a

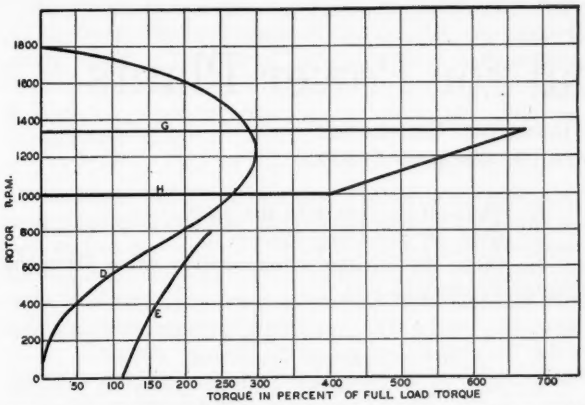


FIG. 2. SPEED-TORQUE CHARACTERISTICS OF CLUTCH TYPE INDUCTION MOTOR

self-energizing, or snubbing effect is set up which causes the intensity of the impulses to increase. This enables the motor to overcome the resistance of high points in the torque curve of the load, such as are caused by sticky bearings, a heavy wad of clothing passing through the wringer rolls of a domestic washing machine, and the like. Under similar circumstances, an ordinary motor would pull-out, or in case of starting would stand still on the line and burn up.

Clutch facings are of molded friction material similar to that now being used on brakes and clutches of high-grade automobiles. The proportions are generous, the area per horsepower being about six times as great as in the clutch of a standard pleasure vehicle. Furthermore, the multiple impulse action of the clutch protects the parts, first, because as pointed out above, it will overcome temporary overloads; secondly, because of the fact that the rate of generation of heat is relatively low as compared to pure sliding action.

Another feature of importance in connection with the operation of "split-phase" motors is the relation of the operating speed of the clutch to that of the centrifugal switch controlling the starting winding of the motor. The ordinary "split-phase" motor, which is used for operation on single-phase circuits, employs two windings—a main or running winding and a starting winding of light wire. This starting winding is displaced both mechanically and electrically with respect to the main winding in order to produce a rotational effect rather than the purely reciprocating effect obtained on a squirrel-cage motor with the rotor stationary and with single-phase excitation. This starting winding is ordinarily open circuited by means of a centrifugal switch operating at approximately three-fourths of full load speed. It is heavily loaded during its operating cycle and will overheat and burn out in case of an extended period of excitation. Danger of a burnt-out starting winding is eliminated on this clutch motor by setting the centrifugal switch to operate at a speed below the releasing speed of the clutch mechanism. The shaft of the motor can be locked for a period of 10 to 15 min. with full voltage at the terminals and no serious damage will occur to the motor parts.

It will be noted from the construction that the clutch is two directional—the only change necessary to obtain the opposite direction of rotation of the motor being the reversal of two leads attached to binding posts on the outside of the motor. Since the motor depends upon energy stored in the rotor during the free accelerating period to provide starting torque, the windings can be designed for low starting current. The needle swing is no greater when starting against a heavy load, or locked shaft, than when starting light.

In addition to offering certain advantages over present split-phase motors, this unit presents the possibility of substitution on some applications for more expensive types of construction.

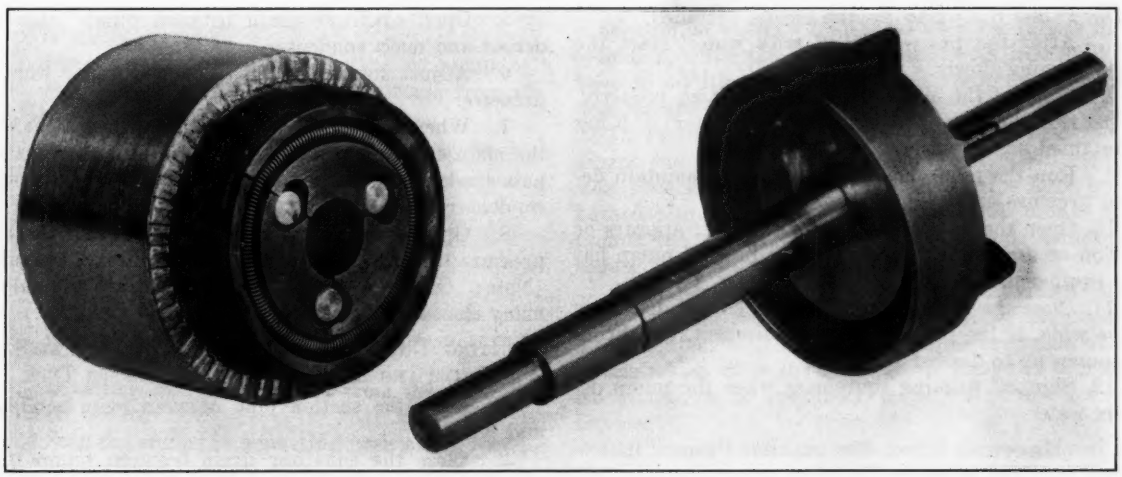


FIG. 3. ROTOR, WITH SHAFT REMOVED, SHOWING SEGMENTS AND GARTER SPRING

ALL ELEVATOR winding machines are equipped with brakes. They should be capable of exerting a holding torque equal to the full load torque of the motor and are often provided with dashpots to assist in smooth operation without gripping.

ENGINES USED for marine, railroad, rolling mill, hoisting and similar work are reversing and have special valve gears of the link or radial types.

Operating Code Manual for Power Plants

DIRECTIONS FOR PROPERLY OPERATING CIRCULATING WATER PUMPS, AIR PUMPS AND CONDENSATION PUMPS

MANY TYPES of condenser auxiliaries, that is circulating, air and condensate pumps, are available and each type requires more or less individual treatment in order to get the best results. Many times, several types are available in the same plant, leading to confusion of the operator unless definite instructions such as those below are given:

STARTING CIRCULATING PUMPS

1. Inspect the condenser for open doors and see that the vent on the tail pipe is open unless a syphon is provided.
2. See that the condenser washout valve in the water box is closed.
3. See that the discharge valve is closed, if one is used.
4. Admit water to the seals of the pump.
5. Prime the pump by the means provided.
6. After the pump is filled with water, start the pump turning slowly.
7. See that the oiling system is operating properly.
8. See that the proper supply of water is being maintained on the coolers.
9. Run the pump at a speed that will maintain desired pressure on the pump.
10. Open the discharge valve until water appears or suction occurs at the vent on the tail pipe, if pump has this equipment.
11. Close the tail pipe vent and open the discharge valve wide, if the pump has this equipment, and bring the pump up to desired speed.
12. Shut off priming equipment when the pump delivers water.

SHUTTING DOWN CIRCULATING PUMPS

1. Stop the pump.
2. Close the discharge valve, if necessary.
3. Shut off the water to the seals.
4. Shut off the water from the oil cooler.

STARTING HYDRAULIC, INDEPENDENTLY DRIVEN AIR PUMP

1. Admit water to the seals of the pump.
2. Open the hurling water priming valve until the desired pressure is reached.
3. Start the air pump at slow speed.
4. See that oiling system is working properly.
5. Bring the air pump to normal speed.
6. Change over from priming to normal hurling water.
7. See that normal vacuum is produced by the pump.
8. Open the air suction valve gradually and, if necessary, adjust the suction valve so that it functions properly.

SHUTTING DOWN HYDRAULIC, INDEPENDENTLY DRIVEN AIR PUMP

1. Close the air suction valve.
2. Stop the pump.
3. Shut off the water to the seals.
4. Shut off the oiling system.
5. Close the hurling water suction valve after the pump has come to rest.

STARTING STEAM JET AIR PUMP, TWO-STAGE INTER AND AFTER SURFACE CONDENSER TYPE

1. See that auxiliary cooling water is passing through the pump condenser, if pump is so equipped.
2. Open air suction pipe between main condenser and pump. (Note: On pumps with multiple elements, open suction valves to all elements and bring all in operating on starting.)
3. See that the drain from the pump after-condenser is open.
4. Open steam throttle and pass steam through secondary nozzle.
5. Open equalizer drain between pump inter-condenser and main condenser.
6. Adjust steam throttle to secure proper working pressure.
7. When proper back pressure has been secured in the main condenser and the turbine put into operation, pass condensate from main condenser through the pump condenser instead of raw circulating water.
8. Open primary steam nozzles and bring the back pressure in the main condenser as low as possible. (Note: On pumps with multiple elements use only as many elements as are necessary to remove the air.)

SHUTTING DOWN STEAM JET AIR PUMP, TWO-STAGE INTER AND AFTER SURFACE CONDENSER TYPE

1. Close the suction pipe between main condenser and pump.
2. Close the equalizer drain between pump inter-condenser and main condenser when pump has separate inter-condenser.
3. Close steam throttle.

STARTING CORLISS ENGINE-DRIVEN AIR AND CIRCULATING PUMP

1. Open all drains from the steam cylinder.
2. Open the exhaust valves and exhaust line drains.
3. Disconnect the wristplate from the eccentric rod hook.
4. See that the oiling system is working properly before and after starting.
5. See that the cranks, crossheads and other movable parts are not obstructed by any foreign material.
6. See that the crosshead pins, crankpins and valve gear pins are tight.
7. See that the crank is in such a position that it will start readily.
8. Open the air cylinder discharge valve.
9. See that cooling water is turned on to the air cylinder jacket.
10. See that water is turned on to the circulating pump seals.

11. Prime the circulating pump by means provided.
12. Open the discharge valve on the circulating pump. (Note: Because of large clearances and absence of suction valves in certain pumps, it may be necessary to keep the discharge valve closed until the pump is turning over slowly.)
13. Place the bar in the wristplate of the engine.
14. Open the throttle valve slightly and rock the valve gear with the bar, admitting steam alternately to each end of the cylinder, warming it up and allowing the piston to move backward and forward a number of times to clear the cylinder of water. Note whether any bearings are loose when rocking.
15. Close the throttle, then engage wristplate with eccentric rod hook and lock it in place.
16. Open the throttle.
17. Turn the engine over slowly.
18. Open the suction valve of the circulating pump slowly and see that water starts to circulate.
19. Bring engine up to normal speed.
20. See that the oil pump is removing oil from the reservoir.
21. Close the drains.
22. Shut off priming equipment.
23. Open the air suction equalizing valve on the pump, if one is provided.
24. Open the air suction valve on the air pump.
25. See that there is no excessive leakage from the circulating pump glands.
26. See that the lubricators on the air valves and steam cylinders are operating.

Shutting Down Corliss Engine-Driven Air and Circulating Pump

1. Partly close the throttle valve.
2. Close the circulating pump suction valve.
3. Close the throttle until the engine is turning slowly.
4. Disengage the eccentric rod from the wristplate and insert the bar.
5. Stop the engine in a starting position by rocking the wristplate with the bar.
6. Close the main throttle valve.
7. Place the wristplate in central position.
8. Open drains before closing exhaust valve, if non-condensing.
9. Exhaust valve should be closed and drains opened.
10. Shut off the oiling system.
11. Close the air suction valve on the air pump.
12. Shut off water to air cylinder cooling jacket.
13. Close the discharge valve on the circulating pump.
14. Shut off water to the seals.
15. Make a general inspection.

Starting Wet Pump, Centrifugal Type

1. Admit water to the seals.
2. Open the suction valve.
3. Open vacuum equalizing line.
4. Start the pump, turning slowly.
5. See that the oiling system is working properly.
6. Open the discharge valve, if not already open.
7. See that the proper water level is maintained in the hotwells to which the pump that is operating is connected. (Note: If the water level rises and one pump does not meet the demand, a second pump must be put into operation. Look for air leaks around the pump in putting on the second pump.)

Shutting Down Wet Pump, Centrifugal Type

1. Stop the pump.
2. Close the discharge valve, if pump is provided with check valve.
3. Close the suction valve, if necessary.
4. Close the vacuum equalizing line.
5. Shut off the water to the seals.

Many Types of Pumps Available

Steam pumps are made of different materials to meet different conditions of service. Trade pumps ordinarily carried in stock are standard, bronze and full bronze fitted, while acid resisting, all bronze and all iron pumps are considered as special fitted although they are also carried in stock by some companies.

Standard fitted pumps have iron or steel ends, steel piston rods, iron liquid pistons or plungers, bronze liquid valve seats, guards and springs, and bronze or rubber liquid valves. Piston pumps have bronze liquid cylinders, while the plunger pumps with iron cylinders have in addition iron plunger glands or if steel cylinders, bronze bushed plunger glands.

In bronze fitted pumps bronze piston rods (in all except end packed plunger pumps) are substituted for steel rods and all plunger pattern pumps have bronze bushed plunger glands and throats. Full bronze fitted pumps the substitution is carried a step farther and bronze pistons or plungers are used as well.

Special pumps are made to suit individual conditions. In acid resisting pumps, all parts of the pump in direct contact with the liquid pumped are made of materials which offer the greatest resistance to corrosion. No guarantee is ordinarily made on pumps for acid service.

All bronze or all iron pumps are also considered special. As the name signifies, all parts of these pumps coming in contact with the liquid pumped are made of bronze or iron as the case may be.

Packed piston pumps of the standard fitted type are usually called trade pumps, a term which covers all single or duplex horizontal direct acting steam pumps of this type of twelve inch stroke or less. Capacities are based on piston displacement, ignoring the rod. For boiler feed service, 34.5 lb. of water is considered as a boiler horsepower.

Trade pumps are usually supplied with drip cocks and drain plugs for steam and water cylinders, special wrenches, oil or grease cups for rocker shafts, companion flanges for openings up to 6 in., and piston packing for the water end only, as standard equipment. For inside packed plunger pumps, packing is furnished but it is not supplied for outside packed plunger pumps. Maximum trade pump sizes are usually considered as 14 by 8½ by 12 in. for 150 lb. pressure and 10 by 8½ by 12 in. for 75 lb. pressure.

Diesel engines have been built in sizes up to 15,000 hp.

Importance of Water Supply for Desuperheaters

WATER USED DEPENDS UPON TYPE OF DESUPERHEATER. CONDENSATE IS BEST FOR DIRECT CONTACT TYPE. BY C. A. BUTLER, JR.

INCREASED USE of higher steam pressures and temperatures in central power stations and industrial power plants has made necessary the installation of an increasing number of desuperheaters. This is especially true where steam extracted or exhausted from prime movers is used for heating and process work and where plants have been rehabilitated by the installation of high-pressure boilers supplying steam to new turbines, or engines, exhausting into existing low-pressure machines. Most of these desuperheaters are installed as standby equipment in connection with reducing valves, for use only to supply low-pressure steam when the high-pressure engine or turbine is out of service. A few plants, however, require desuperheaters in normal operation, due to peculiar heat balance conditions.

TABLE I. CHEMICAL REACTIONS WHICH LEAVE SOLUBLE PRODUCTS IN FEEDWATER

IMPURITY IN RAW WATER	REAGENT USED IN TREATMENT	INSOLUBLE PRODUCTS (Removed by sedimentation or filtration)	SOLUBLE PRODUCTS (Remaining in treated water)
Calcium Sulphate	Soda Ash	Calcium Carbonate	Sodium Sulphate
Calcium Nitrate	Soda Ash	Calcium Carbonate	Sodium Nitrate
Calcium Chloride	Soda Ash	Calcium Carbonate	Sodium Chloride
Magnesium Sulphate	Hydrated Lime & Soda Ash	Magnesium Hydrate & Calcium Carbonate	Sodium Sulphate
Magnesium Nitrate	Hydrated Lime & Soda Ash	Magnesium Hydrate & Calcium Carbonate	Sodium Nitrate
Magnesium Chloride	Hydrated Lime & Soda Ash	Magnesium Hydrate & Calcium Carbonate	Sodium Chloride
Calcium Bicarbonate	Caustic Soda	Calcium Carbonate	Sodium Carbonate
Magnesium Bicarbonate	Caustic Soda	Magnesium Hydrate	Sodium Carbonate
Magnesium Sulphate	Caustic Soda	Magnesium Hydrate	Sodium Sulphate
Magnesium Nitrate	Caustic Soda	Magnesium Hydrate	Sodium Nitrate
Magnesium Chloride	Caustic Soda	Magnesium Hydrate	Sodium Chloride
Calcium Bicarbonate	Zeolite		Sodium Bicarbonate
Magnesium Bicarbonate	Zeolite		Sodium Bicarbonate
Calcium Sulphate	Zeolite		Sodium Sulphate
Magnesium Sulphate	Zeolite		Sodium Sulphate
Sodium Carbonate	Sulphuric Acid		Sodium Sulphate

WATER USED DEPENDS UPON TYPE OF DESUPERHEATER

Desuperheaters may be divided into two general types: First, the indirect or surface type, which resembles in construction a closed feedwater heater. In this type the steam to be desuperheated usually passes through the tubes; the heat removed from this steam passes through the tube walls and evaporates the desuperheating water, which does not come into contact with the steam. In some installations, however, the additional steam thus generated is afterward mixed with the desuperheated steam.

Direct contact desuperheaters are of the second type. They vary in form from a simple jet, sometimes homemade, which injects the desuperheating water into the pipe line carrying the steam to be desuperheated; to an elaborate piece of equipment containing iron rings for hastening the absorption of the water by the steam and baffles for removing the excess water. The distinguishing feature of this type is the intimate mixing of the steam with the water injected to reduce the superheat. This type of desuperheater is far more widely used than the surface type.

SOURCE OF WATER SUPPLY

Usually it is most convenient to take the desuperheating water from the boiler feed header but, if the boiler feedwater is not pure condensate and contains a considerable percentage of treated water, it may not be suitable for use in direct contact desuperheaters. Any water which is suitable for boiler feed may be used in desuperheaters of the surface type. If it contains soluble salts as a result of chemical treatment, these salts will remain in the desuperheater and serve to increase the concentration therein. This concentration must be controlled, as in boiler operation, by periodic or continuous blowdown.

Due to almost complete evaporation of the water in the direct contact desuperheater, any soluble salts therein will be carried along in the steam as solids. These solids, if present in any appreciable amount, will clog up strainers and cause reducing valves and throttle and other engine and turbine valves to stick. These solids will not cause trouble if the desuperheated steam is used directly in heat transfer equipment such as heaters and evaporators, because the salts will be redissolved when the steam is condensed. If the steam is used in process work, the effect of the solids on the product must be determined for each individual case.

SUMMARY SHOWS RELATIVE TREATMENT EFFECTS

Summaries of the more common scale-forming impurities found in natural water and the usual methods of treatment for each to make them suitable for boiler feed are given in the tables. Table I shows that all water treated with soda ash, caustic soda or zeolite contains sodium compounds, which are all extremely soluble in hot or cold water and cannot be removed by filtration or sedimentation after the treatment. Water so treated should not be used in direct contact desuperheaters when the desuperheated steam is used in engines or turbines or when it passes through strainers or reducing or control valves, unless the proportion of salts in the water is very low, such as in boiler feedwater consisting of a comparatively large proportion of condensate with a small amount of treated water added as make-up. No general rule concerning the maximum permissible concentration can be stated, as this depends entirely on

TABLE II. CHEMICAL REACTIONS WHICH DO NOT LEAVE SOLUBLE PRODUCTS IN FEEDWATER

IMPURITY IN RAW WATER	REAGENT USED IN TREATMENT	INSOLUBLE PRODUCTS (Removed by sedimentation or filtration)
Calcium Bicarbonate	Hydrated Lime	Calcium Carbonate
Magnesium Bicarbonate	Hydrated Lime	Magnesium Hydrate & Calcium Carbonate
Calcium Sulphate	Barium Carbonate	Calcium Carbonate

the equipment in which the steam is used. Table II shows that water which may be treated satisfactorily with lime only or with lime and barium sulphate, contains no soluble compounds after treatment, hence may be used in direct contact desuperheaters regardless of the use made of the desuperheated steam.

Use of Condensate

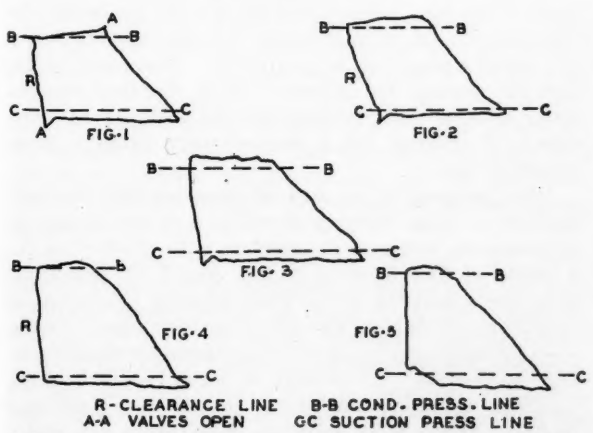
Condensate should be used as desuperheating water in direct contact desuperheaters whenever practicable. When the boiler feedwater is composed of a large proportion of treated water which cannot be used for desuperheating, some means must be provided for supplying condensate to the desuperheaters. Condensate may be supplied directly from the condensate pumps, in cases where the minimum pressure at the discharge of the condensate pumps is greater than the pressure of the steam to be desuperheated. A few plants have their boiler feed pump suction systems arranged so that one or more of the boiler feed pumps may be supplied with condensate only in which case the desuperheaters may be supplied only from the discharge of these pumps. When neither of these schemes is possible, separate pumps must be installed to supply the direct contact desuperheaters with condensate.

Indicator Diagrams from a Refrigerating Compressor

By W. E. Warner

INDICATOR DIAGRAMS taken from a refrigerating compressor are a valuable guide to the conditions existing in the cylinder. Taking these diagrams is not difficult and, as most makers indicate their compressors on the test bed, an indicator diagram should be easily obtainable from them which can be used to compare with any diagrams subsequently taken. A diagram taken from a compressor in good condition should appear as that shown in Fig. 1. The line marked R is that due to the clearance and the two small projections A, A are due to the power required to operate the valves.

Diagram, Fig. 2, was taken from a compressor with excessive clearance. It will be seen that the line R follows a more nearly straight course.



FIGS. 1 TO 5. INDICATOR DIAGRAMS FROM REFRIGERATING COMPRESSORS SHOWING EFFECT OF DIFFERENT CONDITIONS

Figure 3 shows a diagram from a compressor with too great a resistance in the pressure and suction pipes. It will be seen that the lines of the diagram are a comparatively long way from the atmospheric line and condenser pressure line. This condition can often be remedied by using weaker valve springs, or by cleaning the connecting pipe line if this is necessary.

Figure 4 shows a diagram from a compressor with leaky valves; it will be noted that the diagram is extremely rounded.

Figure 5 is caused by the defective packing of the compressor piston which permits vapor to leak past the piston rings. It will be seen that the compression line is long, the diagram is rounded and there is a depression at the foot of the diagram. It must be remembered that several defects may exist in a compressor at the same time, which may cause the diagram taken to be variously distorted according to the defect. In any case these diagrams will form a valuable guide when trying to locate faults, as defects will be shown up which are thought nonexistent. They show the internal conditions existing of which there is no other guide. Taking these diagrams after overhauling and during testing will give a valuable indication as to the exact condition.

Stokers for Hudson Avenue Station

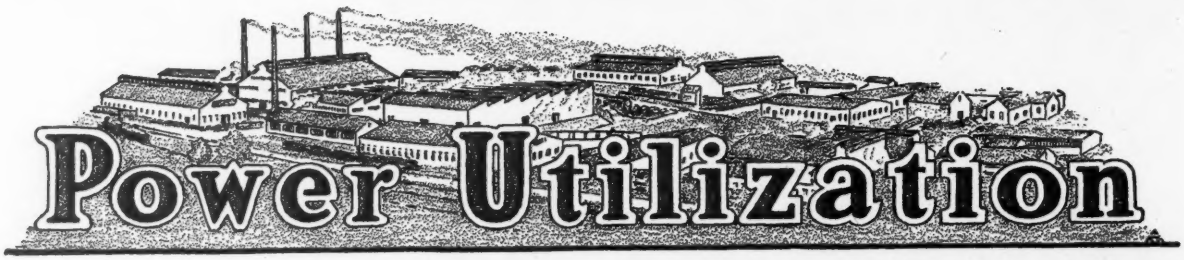
American Engineering Co. was awarded the contract for eight high capacity Taylor stokers for the new boiler units to be installed in the extension to the Hudson Avenue Station of the Brooklyn Edison Company, Brooklyn, N. Y. The stokers will be single units approximately 26½ ft. wide and 27 ft. deep. They will be the longest stokers ever manufactured, it is claimed, extending over three feet longer than any existing single unit stokers in operation.

Some stokers in the past have been increased in size by widening the stoker, using more retorts. These stokers will be 15 retorts wide and 69 tuyeres deep. The operating mechanism will be designed and made adequate for still increased lengthening for future stokers of this type up to 81 tuyeres deep.

Each stoker will be designed for burning approximately 60,000 lb. of coal per hour, to develop 530,000 lb. of steam from each boiler per hour. Control of the fuel feeding mechanism will be by electric motors and the coal pusher mechanism is made adjustable over the entire width and length of each stoker. Adequate ash disposal mechanism equipped with crusher rolls 36 in. in diameter will be provided to take care of the ash from the large quantities of coal that will be burned. Delivery of the stokers will start the first of the year, and erection completed by the latter part of 1931.

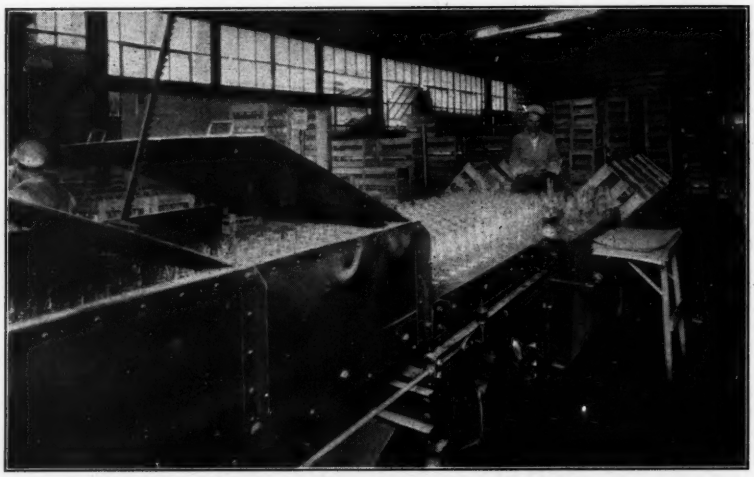
New orders for 1309 steel boilers were placed in July, as reported to the Department of Commerce by 81 manufacturers, comprising most of the leading firms in the industry, as compared with 1360 boilers in June and 2052 in July, 1929.

In practice, the organization of a successful power plant crew will differ with the type, size and operating necessities of the plant itself. The underlying principle, however, is the same in each case; that is, coördination.



POWER and HEAT in a GLASS PLANT

By
John W. Romig
Mechanical Engineer
Corning Glass Works



DURING the past 20 yr. the glass bottle industry has changed its methods from the picturesque hand blowing system to that of automatic machinery. The advent of machinery for working and forming of hot glass in large quantities has brought the industry into prominence as a user of energy in many forms and in large quantities. Machines for the forming of glass have in most instances been developed in such a manner that they mechanically duplicate the hand process when men gathered the molten glass on a hollow rod or blow pipe, cooled the glass, placed it in a mold and blew it by air pressure from the lungs. The machines require hot glass, which is tempered and cooled during the working process and finally formed; so fuel is required for heating, power for operating the machines, low pressure volume air for cooling and compressed air for blowing and for certain machine motions. When the bottle is formed, it passes through annealing ovens which allow the bottle to cool uniformly, thus making the product tough so it will not shatter under bottling conditions.

Raw materials other than fuel consist principally of sand, soda ash and lime; all heavy bulky materials must be unloaded, stored, proportioned, mixed and delivered to melting furnaces. Melting furnaces or tanks are kept at high temperatures with producer gas, fuel oil or natural gas; producer gas, because of low cost, is used more than other fuels. Large quantities of coal are required for production of producer gas in gas producers so the coal handling system is an important cog in the plant operation.

To describe the use of energy as applicable to all glass plants would require an extensive treatise, as the type of machines, the product and the processes vary widely. In many basic respects, the use of energy is similar, although the quantities and method of application are quite different. The application and distribution of power and heat in an existing plant will be discussed. The plant discussed herein is principally a bottle manufacturing plant; although some other products are made, the manufacture of glass bottles has had a predominating effect on the energy systems. Energy in the following forms is used—electric power, steam, compressed air, dry vacuum, water, fuel oil, fuel gas of a refined type, and producer gas from gas coal.

Source of Electric Energy

Electric energy in a quantity averaging 2200 kw. per hour is demanded almost continuously 24 hr. a day, six days a week under normal production schedules. The source of the energy is largely purchased from the power company; a 1000-kw. turbo-generator unit, however, is used in the heat balance and to provide electricity for operations which if interrupted for even a short period will entail a great loss in production. Items such as the fuel oil system, the direct current electrical system, water system, glass furnace cooling and the gas producers if stopped for a moment may cause a great monetary loss.

For instance, if the fuel oil pressure fails the temperature of glass working chambers gets out of control, a one-minute outage will interfere with production for a period of time between 20 min. and 2 hr. depending upon the sensitivity of the glass forming equipment in operation. A halt in the direct current supply causes glass forming equipment to lose temperature equilibrium for like periods. A shortage of water jeopardizes gas producer agitators, tank water jackets and glass tank cooling. Often weak spots on glass tanks are cooled with water jets. If the jet supply is interrupted the contents of the tank may break through weak refractory

walls resulting in a great loss of glass production and the plant is subjected to a dangerous fire hazard. Blowers are used to cool tanks, if interrupted in operation tank life is jeopardized, while if the gas producers are stopped the temperatures get out of control.

Because of the cost of interruptions, generating equipment is considered essential for purchased power supply is not entirely without interruption faults. To make the distribution system flexible, a purchased power bus and a generated power bus are provided and switching gear is so arranged that either supply can be used for essential service and for production service. Purchased power is stepped down from 33,000 v. to 460 v. while the generator voltage is carried at 460. From the buses circuits are taken for outside lights, inside lights, essential service on fans, blowers and producers, production equipment, air compressors, vacuum pumps, station service and for non-essential circuits at 460 v. Transformers are used to boost the circuit voltage from 460 to 2300 for distribution to the motor generator sets and the water system which includes a pumping station about one-half mile distant. This circuit is termed as essential and is given more attention and consideration than any circuit other than the station service circuit which supplies energy for exitation and other important station auxiliaries.

Uses for Direct Current

Direct-current voltage carried at 230 is very desirable for distribution; synchronous motors drive the d.c. generators and are used for power factor correction. Many plants use 110 v. d.c. with attendant disadvantages such as excessively large generating units, large motors and heavy copper but the 220-v. d.c. system keeps initial costs down and operating losses are lower. The direct current is used mainly for production machines which operate at speeds varying with the nature of the article being manufactured. Effort is made to keep all possible equipment on alternating current as the cost of alternating current is about half that of direct current. Often designers find that the easiest way out in design of drives is to employ direct current motors so it is difficult to maintain ample reserve direct current capacity because of this tendency on the part of development engineers.

In this particular instance, some engineers will question the operation of motor generator sets at 2300 v. instead of 460 v. It is true that a loss of 3 to 4 per cent exists in the step-up transformers but the added advantage of using existing equipment more than offsets the loss in energy when taken into consideration along with the length of lines for distribution and the attendant losses. The time for 2200 v. distribution in large plants is not far off.

Two circuits are employed for lighting. One 460-v. circuit controlled at the power house is used for yard lighting. Transformers set about the plant reduce the voltage to 110 for the lamps. The other lighting circuit is used for inside lighting and transformers connected so that the three-phase system is practically balanced, are placed in centers of lighting loads to reduce the voltage from 460 to 110 v. The city voltage happens to be 110, so much trouble was experienced in the theft of bulbs. Lock sockets and stenciled lamps checked the losses to some extent but were not a cure. The real answer to this difficulty is to provide a plant lighting voltage different from the city voltage; the expense in this instance, however, would not justify the change.

Air Handling by Electric Power

Electric energy directly applied for production is largely used in fans and blowers. Several years ago, it was customary to close glass plants a couple of months during the summer because of the heat. Ventilating equipment, fans, blowers and distribution systems have been developed for cooling men working near the hot tanks and have improved working conditions so that summer shutdowns are no longer necessary. About 200 connected horsepower is required to drive ventilating equipment for cooling men.

High-pressure blowers are used for cooling of mold equipment on glass blowing machines. A total of close to 1500 connected horsepower is used for this necessary adjunct to high production. Of the blower motors four 125-hp. synchronous motors are installed for power factor correction. The other motors are largely 100-hp. units and are of the squirrel cage type.

Besides the previously mentioned synchronous motors, two 550-hp. units are used on air compressors one of which operates almost continuously and a 350-hp. unit on a vacuum pump are used for power factor correction. The result is that the plant power factor is maintained at close to 90 per cent, an excellent industrial power factor. It is of interest to note that the plant load factor is about 70 per cent. The combination of good power and load factors makes an excellent power load.

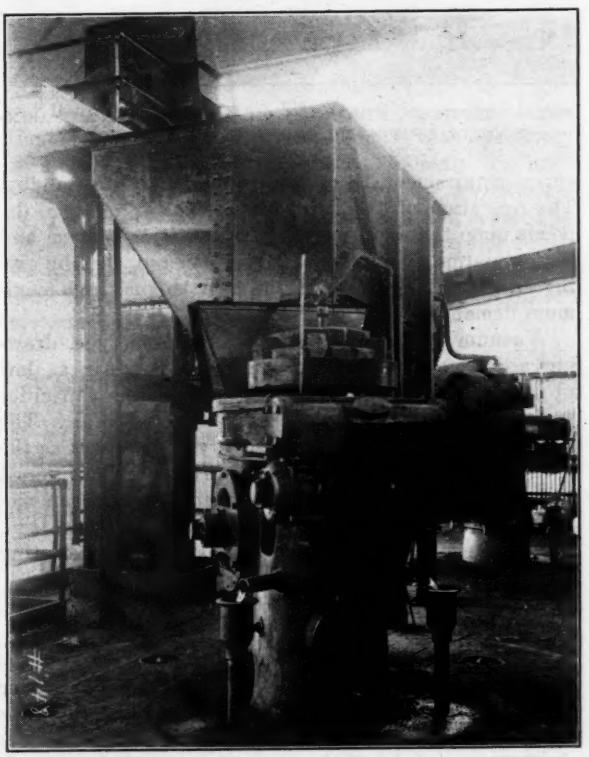


FIG. 1. STOKER AND TOP OF MODERN GAS PRODUCER WHICH WILL GASIFY ABOUT 30 T. OF COAL A DAY

The compressed air system consists of one 175-cu. ft. 100-lb. pneumatic tool compressor, two 5000-cu. ft., 40-lb. synchronous motor driven units, one 5000-cu. ft., 40-lb. unaflow engine driven compressor, one 2000 cu. ft. 40-lb. slide valve engine outfit and three small 80-lb. pressure steam driven compressors for special glass machine operation. The 40-lb. air is used largely for fuel oil atomization, bottle blowing and for operating standard production units. The capacity required allows one 5000-cu. ft. unit to be kept in reserve. The operation of steam and electric units is scheduled so that the proper heat balance is maintained. In warm weather, the steam driven unit will be idle while during the winter months it will operate instead of one of the electric units.

Bottle machines of certain types require a high vacuum. For this service, a 5000-cu. ft. synchronous motor driven machine and a 5000-cu. ft. Corliss valve type compound steam driven unit furnish the required capacity, either unit having sufficient capacity to take care of the

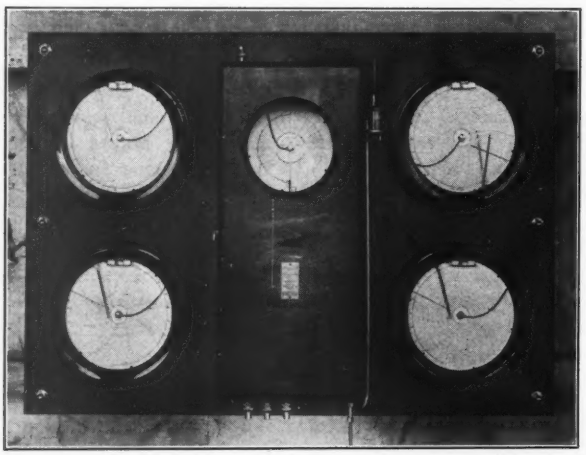


FIG. 2. METERS AND GAGES AID IN ECONOMY AND CONTINUITY OF POWER SERVICES IN GLASS PLANT

entire requirement, thereby affording complete standby. The operation of the two units, steam or electric, depends upon the requirements of the heating system, and for regulation of purchased power demand, thereby giving additional control over the heat balance and maximum demands.

Vacuum pumps are of the dry vacuum type, drawing air from the bottle machine molds. Air at low pressures has a great volume and pipe line capacities are much lower than in the case of compressed air. The power input with a pump of this type decreases as the vacuum increases, in fact the electric pump mentioned above will not start with an open line even though motored about 100 per cent over normal operating load. The problems of such a vacuum system are interesting and in some cases difficult to handle.

Unfailing Water Supply Is Essential

Wells close to the river bank furnish water for the plant. The most recent well is of the concrete strainer type and is nearest to the river. It is interesting to note that the wells nearer the river supply the softest water; the difference of ¼ mi. from the river doubled the hardness of the water, in the case of two wells approximately the same depth. Water is pumped from the wells at about 1200 g.p.m. by means of deep well pumps to a lime treating plant where bi-carbonate hardness is removed by aereating, lime treatment and settling. From the settling basin the water is pumped with constant speed centrifugal pumps into the plant water system and distributed for process, drinking, fire protection and to the boiler room zeolite system. Boiler water is softened in open zeolite softeners as the large amount of permanent hardness in the lime treated water would form a hard scale in boiler tubes.

To guard against a failure in the water supply, three connections are made with the city supply. Two of the connections are made with Deane motor operated valves hand controlled at the power house. An electric alarm on the water system gives notice of too high or too low water pressure and power room operators are able, in case of too low pressure, to take water from the city supply until conditions return to normal. The advantages of a double supply are quite decided in a glass plant, for large losses can readily result from an interruption of only a few minutes.

All pumping equipment used in the water supply system is driven by induction motors wound for 2300 v. The well pumps are of the vertical type having submerged impellers so that priming troubles are negligible. Duplicate motor driven centrifugal pumps are used for distribution of water through the system. The suction pipes leading to the basins are provided with foot valves and each of the pumps is connected with a steam siphon to facilitate priming. Simplicity, ruggedness, duplicate equipment and the essential power supply have been found in this case the answer to the problem of interruptions to water service.

Handling and Use of Fuel Oil

In the fuel oil system is an unloading station so arranged that several cars can be loaded, a rotary bucket type pump taking suction from the tank cars and delivering the fuel oil to storage tanks about ¼ mi. from the factory. The oil can be heated in the storage tanks to such a degree that it either gravitates or is pumped into service tanks near the manufacturing building. Tanks, storage and service tanks are arranged in duplicate so that cleaning schedules with heavy fuel oil are readily maintained without any interference to operation.

Oil in the service tanks is heated to the point of proper viscosity for handling with a centrifugal service pump. Centrifugal service pumps, motor driven, are provided in duplicate for distributing the fuel oil to the loop distribution header. Particular care was taken in the selection of the pumps to secure pumps having flat volume-pressure curves so that the pressure fluctuations with increase or decrease of flow would not interfere with oil burner operation. It was found that the centrifugal pumps gave as uniform pressure as an oil altitude tank gave before their installation. In the installation of centrifugal pumps for handling fuel oil, it has been found advisable to keep a positive suction head on the pump inlet. Failure to observe this precaution leads to trouble with priming and occasional loss of prime, a positive head is a real essential in elimination of fuel oil pressure losses.

Oil from the pumps passes through strainers, with a mesh of 100 to the inch, set in duplicate after the

pumped oil is heated in one of the duplicate heaters. It was found that heated oil passes through strainers much better than heavy cold oil, hence the location of the strainers. If strainers are located in the suction lines trouble with priming occasionally result so that this strainer installation was made in the 65 lb. pump discharge line. Oil gages on each side of each strainer give an indication of strainer pressure drop and show when strainers need cleaning.

High temperature is required to keep low gravity, low viscosity oil fluid so the heaters installed have a capacity for the maximum flow condition. Fuel oil lines are insulated and in order to secure hot oil at the burners about 50 per cent more oil is pumped and recirculated than is consumed, which keeps hot oil coursing through the system at all times. The system as installed has been practically free from interruptions to service. It is interesting to note that the system in place prior to the installation of the present arrangement gave almost continuous trouble.

Connection from the fuel oil system is made to the boilers in the boiler room. This connection is provided so that in case of a sudden increase of boiler load, loss of ignition or grate trouble the steam pressure can be maintained. A fuel oil supply in a boiler room normally burning screenings may be disastrous as to waste of fuel oil, burning it instead of coal; with close supervision and meters, however, the full insurance value of the supply is realized without undue consumption of fuel oil.

Consumption figures of fuel oil passing through the fuel oil system are subject to much variation. One day the consumption may be 5000 gal. while at other times the consumption may reach a peak of 20,000 gal. per 24 hr. The variations being dependent upon the manner of operation of manufacturing equipment, a supply ranging from 500,000 to 2,000,000 gal. of fuel oil is available in the fuel oil storage tanks.

Distribution of refined gas is carried out as in all industrial plants using quantities of city, natural or other refined gas. Producer gas is formed in gas producers of a semi-mechanical type and delivered under low pressure to glass tanks. A top coal consumption figure for producer gas is in the neighborhood of 250 t. per 24 hr. Glass tanks require large quantities of heat, depending upon size and temperature. An average size tank will require producer gas from about 30 t. of gas coal per 24 hr.

Steam is generated at 160 lb. gage from three 280-hp. and two 500-hp. water-tube boilers. A good average figure for steam evaporated is 45,000 lb. per hour although heating season peaks are considerably higher. The 280-hp. boilers do not have superheaters but the two 500-hp. units are provided with superheaters designed to give 100 deg. F. superheat. Boiler room auxiliaries are installed in duplicate, electric and steam driven so that the proper heat balance may be maintained both summer and winter. The 1000-kw. turbine auxiliaries are either steam or electric driven and the turbine is designed so that it will operate either straight condensing, mixed flow, bleeding or atmospheric exhaust. These features give a maximum of flexibility for control of heat balance and purchased power demand. With the duplication of equipment steam and electric in connection with the turbo-generator set high-pressure steam is seldom needed to boost the heating system pressure and during non-heating months no steam is lost through the atmospheric vent. All prime movers use steam at 160 lb.

Process steam for gas producers is delivered at 125 lb. gage. The heating system pressure varies from 2 to 6 lb. gage, depending upon the outside temperature. During extremely cold weather, a higher pressure is required properly to heat the more distant parts of the plant.

Most attention is given in the power and heating systems of this and most other glass plants to reliability of service. Next comes economy of operation. In this particular plant, the two have been combined to a great extent so that the chances of losing service are a minimum and the heat balance and power demand have been studied to keep operating costs down. The general policy is to build with continuity of service as the chief fundamental with operating cost and initial investment considered secondary.

Full Lightning Tests for Commercial Transformers

FULL LIGHTNING TESTS have been applied to commercial transformers for the first time. The high-voltage laboratory of the General Electric Co. at Pittsfield, Mass., has repeatedly subjected transformers of the new non-resonating type to 3,000,000-v. lightning waves.

The transformers, built at Pittsfield for use on the Fifteen Mile Falls 220,000-v. transmission line of the New England Power Co., are rated 13,000 kv-a. each. The lightning tests, conducted under the direction of F. W. Peek, Jr., on August 8 and 12, were made immediately after the commercial tests of the units were completed.

The 3,000,000-v. lightning waves used in the tests were conducted from the high-voltage laboratory over a short line to the testing department and repeatedly applied to the transformers. The transmission line insulation arrangement was made to compare with operating conditions, with 15 shielded units on the main line and 14 units at the transformer. The lightning waves were of a type to produce the severest stresses and covered a range of time varying from one-half microsecond front to 80 microsconds tail. It was found impossible to break down the transformers in the tests and a repetition of the commercial tests showed no damage.

HUSBANDS, economists, statisticians and various other types of misogynists have insisted, since time immemorial, that women's talk is largely quantitative instead of qualitative but the results of the national employes' speaking contest, conducted under the auspices of the National Electric Light Association, offers the first concrete evidence on this point.

Of the approximately 4200 employes of light and power companies scattered all over the United States who participated in the contest, 45 per cent, or 1890, were women, and 55 per cent were men. Out of the thirteen winners of the various geographic division contests, however, only 2, or 15.3 per cent, were women, while 11, or 84.7 per cent, were men. This may or may not mean that the conversations and discussions of men have five times the value of those of women. It depends on one's point of view.

Pneumatic Conveying

REQUIREMENTS, DATA AND PERFORMANCE. BY H. H. WEISS*

MATERIALS have been conveyed by air through pipe lines for over 30 yr. in Europe but not in this country to the same extent because the fundamental requirements for factory operating system have not been understood and differences of opinion exist.

Recently a prospect received proposals on a conveyor to handle a specific amount of material for 4, 5, 6 and 8-in. pipe and for horsepower from 100 to 300. He was at a loss to determine what figures were right.

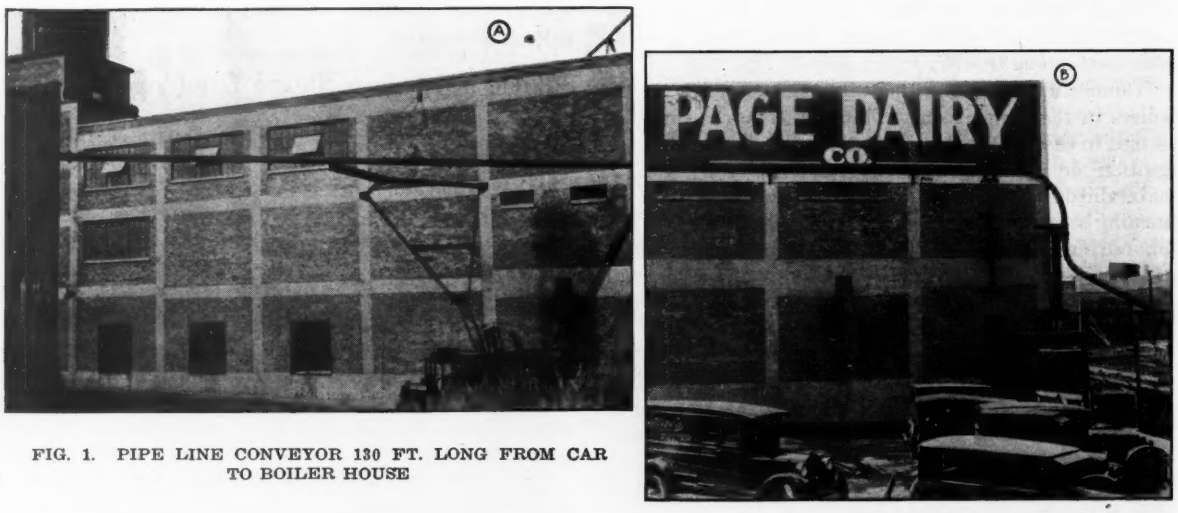


FIG. 1. PIPE LINE CONVEYOR 130 FT. LONG FROM CAR TO BOILER HOUSE

Every proposition should be designed and figured as an individual problem, not overlooking the slip of the blower at different speeds nor the loss of air due to compression in the pipe line and the pressure created. If this loss factor is disregarded, a conveyor will never give the required capacity.

FUNDAMENTAL ITEMS

To convey materials pneumatically, three factors are essential; namely, air, volume and velocity. A common example of pneumatic conveyance is a high wind or tornado. A certain volume of air moves at high velocity and materials are carried great distances by this means. Conveying material by a volume of air moving at high velocity may be useful and beneficial when completely under control, confining the air moving to a fixed area in some form of conduit or pipe. Conveyor capacities are dependent upon the volume of air and the velocity. Velocity is dependent upon the volume of air and the pipe diameter. Different materials have different specific gravities; hence require different volumes of air and different velocities to keep a given weight in motion in a closed conduit. Theoretical knowledge alone will not cover practical requirements.

To deliver a volume of air a positive delivery blower must be used, such as the P. H. Roots, the Connersville, or the Wilbur Green.

*Brady Conveyors Corp'n.

All positive displacement blowers deliver a definite volume of air per revolution, the pressure at the discharge end of the blower depending on the resistance to the flow of air. The pressure at which the blower must operate is determined by the friction resistance in the pipe line for a given diameter pipe per hundred feet and by the increased loss due to the introduction of material. A positive pressure blower will stand for an overload, still delivering the positive volume building up an increased velocity due to any material restrictions in the pipe line, if the driving power available is sufficient to overcome this increased pressure.

GENERAL ARRANGEMENT OF A PNEUMATIC SYSTEM

Primarily, a pneumatic system consists of a flexible hose and nozzle placed in the railroad car, usually supported by an overhead swinging boom. Material is sucked out of the car, on the principle of an ordinary vacuum cleaner, through a pipe line to a receiving chamber, then carried to the bunker or storage pile. Separation of air and material takes place in the receiver and any fine coal dust entrained in the air which might pass the receiver is taken through an air scrubber or washer where it is under water. Operation of the system is accomplished without raising dust. Either a dry cloth bag filter or an air washer is used between the receiving station and the exhaust blower.

ENGINEERING DATA

In pneumatic conveying, the application of theoretical formulas and mostly practical experience form the basis of sound engineering. It is known that a cubic inch of any material weighing anywhere from one ounce to a pound will travel in a pipe line (carried in suspension) at a certain velocity. The weight of that cubic inch determines the velocity at which it must travel. Regardless of the size of pipe, the velocity is fixed. In

addition to the fixed velocity, a minimum number of cubic feet of air per pound of material conveyed determines the pipe size.

By actual experience, the writer has found that a granular material will travel in suspension in pipe lines at a velocity equivalent to 100 times its weight per cubic foot. In other words, material weighing 50 lb. per cu. ft. will carry in suspension at approximately 5000 ft. per min., 60-lb. material at 6000 ft., and so on. The ratio of cubic feet of air per pound of material conveyed at these velocities is the determining factor in successfully conveying material through pipe lines. To chart a table that could be intelligently used by engineers in figuring pneumatic systems is almost an impossibility, due to the fact that various materials act differently in pipe lines, developing different load friction losses which are determined only by practical experience and comparison with similar materials handled.

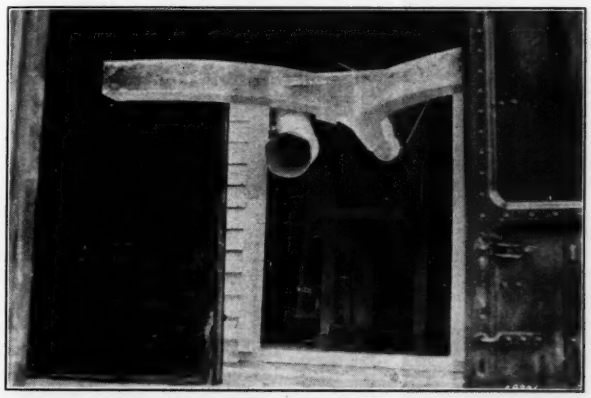


FIG. 2. CAR LOADING SYSTEM FOR POWDERED CHINA CLAY

Numerous boiler plants in the United States burn from 6000 to 10,000 t. of coal annually and are at a considerable distance from railroad sidings. Such plants lend themselves to the installation of pneumatic coal handling equipment. At the plant of the Paige Dairy Co. in Toledo, Ohio, cleanliness is the watchword and maintenance of highly sanitary conditions throughout the entire establishment is the slogan. Although current is purchased for light and power, the company operates a boiler plant for the process steam and to drive a reserve generating set in case of emergency. In the course of a year, about 6000 t. of coal is consumed in the boiler plant, which is over 130 ft. from the railway siding. In the past, coal delivery by auto trucks occasioned more or less dust, so it was decided to install a coal handling system that would eliminate this and, by extending it from the railway siding to the boiler room, to make it possible to purchase coal in carload lots at considerably less cost.

A fully inclosed penumatic system of coal handling was selected, conveying the coal from the car to the pneumatic plant placed in a room above the coal bunker through a pipe line as shown in Fig. 1. The Brady Conveyors Corp. built and installed the system at an initial cost of $9000, giving a saving estimated by the Page management as $1 per ton through cheaper coal when buying in carload lots.

Several interesting installations of pneumatic clay loaders were recently made at plants of Edgar Brothers Clay Co. Crushed clay as fine as flour in amounts of 25 to 40 t. per hr. is blown into railroad cars and the systems are so arranged that the loading is practically dustless. The box car is entirely closed in and the air which carries the material into the car is drawn out with an auxiliary system, in that way creating neutral pressure within so that no dust escapes through any cracks or openings in the car.

Figure 2 shows the bifurcated spout for clay load ing and the single exhaust pipe through which air is drawn at low velocity. The picture was taken with both car doors open. In action, one door is closed, the other has a heavy tarpaulin cover.

Largest and Smallest Overhung Generators

LARGEST AND SMALLEST overhung-type hydroelectric generators are being constructed simultaneously at the Schenectady works of the General Electric Co. The largest, rated at 56,250 kv-a. is for the western coast; the smallest, rated at 3300 kv-a., is for the eastern coast. Installation of the largest is to be made by the Inland Power & Light Co. of Washington at a point called Ariel, about 40 mi. up from the mouth of the north fork of the Lewis River. The unit, which will be delivered early in 1931, is technically rated 60 pole, 56,250 kv-a. (45,000 kw., 0.8 power factor), 120 r.p.m., 3-phase, 60 cycles and 13,800 v. The water turbine, to be supplied by the S. Morgan Smith Co., is guaranteed to supply 61,600 hp. with a 185-ft. operating head, and it is expected that 67,000 hp. will be developed at a 189-ft. head. Four smallest overhung hydroelectric generators, rated at 3300 kv-a. each, are being made at the same time for the Grafton Power Co., for installation this fall on the Connecticut River at McIndoes Falls, Vt. The complete rating of these units is 48 pole, 3300 kv-a., 150 r.p.m., and 2300 v. Of these machines two are to be driven by Kaplan adjustable blade propeller type water wheels, by means of which variations in load and operating head are automatically cared for. The water wheels are being supplied by the S. Morgan Smith Co.

Swiss Steam Turbine for the Anaconda Copper Co.

ESCHER WYSS & Co. of Zurich, Switzerland, has recently completed a contract from the Anaconda Copper Co. of New York for a steam turbine for normal and maximum outputs of respectively 20,000 kw. and 25,000 kw. for the Tocopilla plant. The machine has been designed as a single-casing turbine for coupling direct to a Siemens-Schuckert three-phase generator. The initial steam conditions are 14 atmospheres (200 lb. per sq. in.) at a temperature of 650 deg. F. New boilers will be erected later on and the steam pressure and temperature will then be raised to 28 atmospheres (400 lb. per sq. in.) and 725 deg. F. respectively. The vacuum at full load amounts to about 95 per cent (28.5 in. Hg). The steam consumption is claimed to be just as favourable as with a multi-casing turbine but the space required considerably smaller.

Accident Hazards in the Engine Room

CAREFUL DESIGN, SAFETY DEVICES, LUBRICATION PRACTICE AND OPERATING PRECAUTIONS ARE ESSENTIALS IN PREVENTING ACCIDENTS. BY W. DEAN KEEFER*

PEOPLE still recognize the engine room as a hazardous department. We still have "No Admittance" signs, excepting for those whose duties require them to enter. Many serious engine room accidents have occurred. Yet a large percentage of the accidents in the modern engine rooms are trivial and common to a good many other industrial plant departments.

velopment of the plan in modern industry, of trained safety engineers. One of the important duties of the average plant safety engineer is to watch the hazards of the engine room.

At a recent Annual Safety Congress the relative value of the service of the safety engineer was well stated by F. R. Jensen, chief engineer of Armour & Co.

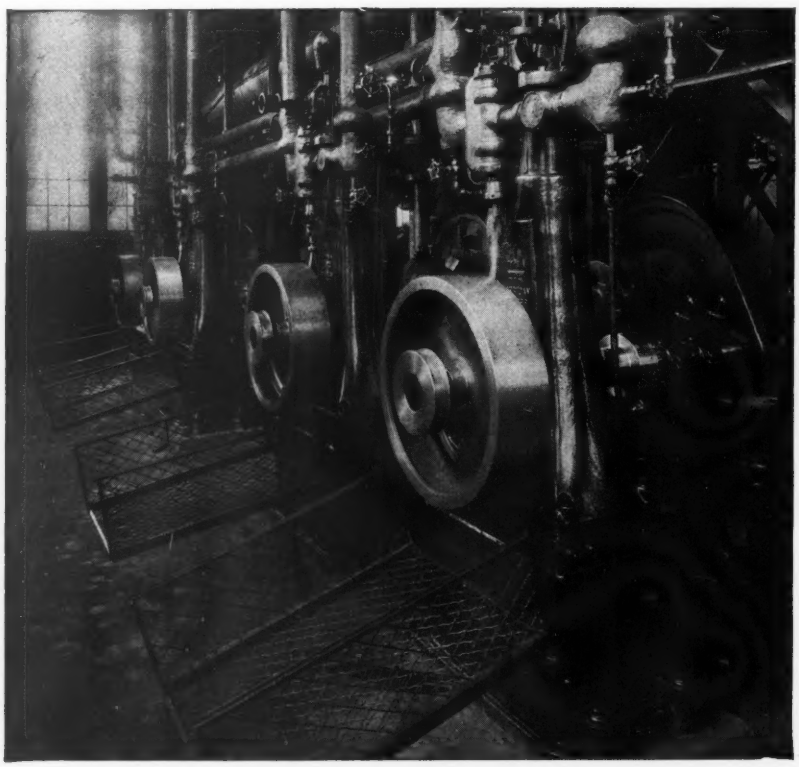


FIG. 1. GUARDS OVER ENGINE FLYWHEEL, DIRECT CONNECTED TRIPLEX PUMPS, REMOVED FOR WIPING

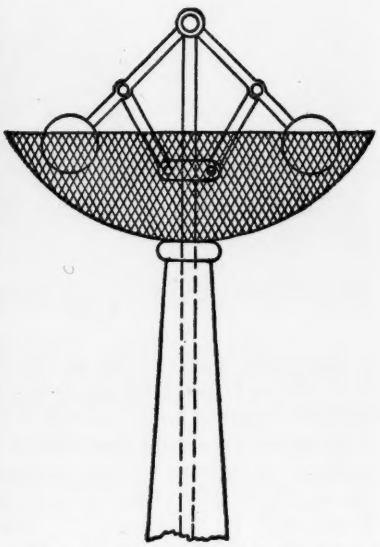


FIG. 2. BASKET GUARD PREVENTS STRIKING GOVERNOR BALLS

Probably the most common hazard in the engine room is the danger of slipping or tripping. The careless handling of oil is one of the chief contributing causes. Other causes are failure to keep the floors clean, loose floor plates, uneven surfaces and poor lighting.

As compared with accidents in other departments, the total of accidents in engine rooms is usually not large. The total, however, is large enough to emphasize the need of safety precautions. Safety precautions are good business and they reflect a common-sense viewpoint toward the welfare of employees. A good chief engineer in an engine room naturally will be watchful to eliminate or control accident hazards. Yet he may need special training to recognize all major and minor accident hazards. This is one especial reason for the de-

"The chief engineer," said he, "should at all times make use of the safety engineer. And every accident, no matter how small, should be given the greatest publicity, so as to study it with the view of preventing similar accidents in the future. Regular inspection of the department by the safety engineer and daily watchfulness should be insisted upon. All dangerous places and practices should be pointed out and particular attention given to these.

"The importance of the safety engineer, in every industrial organization, is being more and more recognized and the chief engineer should work hand in hand with the safety engineer, in order to devise ways and means of accident prevention. The safety engineer is of great importance in educational campaigns, as he specializes in this work and has more opportunity than

*Director, Industrial Safety Division, National Safety Council.

those in the supervisory force to observe accident causes."

Naturally, the chief engineer of the engine room is interested in cost figures. This should include the cost of accidents. Therefore, the most convincing arguments for increased safety precautions in the engine room may come from monthly tabulations of accident costs. But the mere tabulation of the number of accidents often does not tell the full story, since an accident in the engine rooms, when it does occur, may represent a very large direct or indirect cost.

A. J. Authenrieth, vice-president of Middle-West Utilities Co., in discussing before the 1929 Safety Congress the problem of hazards in the engine room, divided the entire problem of accident elimination into three sections. He designated these as "correct design and equipment in the engine room," "safety precautions in operating methods," and "care in the selection and training of the engine room personnel."

"The engineer," he stated, "is usually a man of long experience and his knowledge enables him to handle his plant tasks with assurance and safety borne of this knowledge. Nevertheless, we must design our production department with care and operate with precision if we are to keep accidents at a minimum."

Mr. Authenrieth, at the time, was supervising director of 300 ice plants which had made an enviable record in keeping down accident costs. It had always been his program, in the construction or reconstruction of an ice plant, to submit his blue prints to the department of safety of his organization to receive the comments and criticisms of those who were specialists in this work.

Provision of Safety Devices

In accident prevention in the engine room, the first step is to build into the equipment as many safety devices as are necessary. Many protective devices of course are worked into the design of modern machinery. But there usually are many exposed parts which must be protected according to the discretion of the construction or operating engineer. This includes the protection of all unguarded belt-driven equipment, flywheels, pulleys and all reciprocating parts which protrude from the body of the machine.

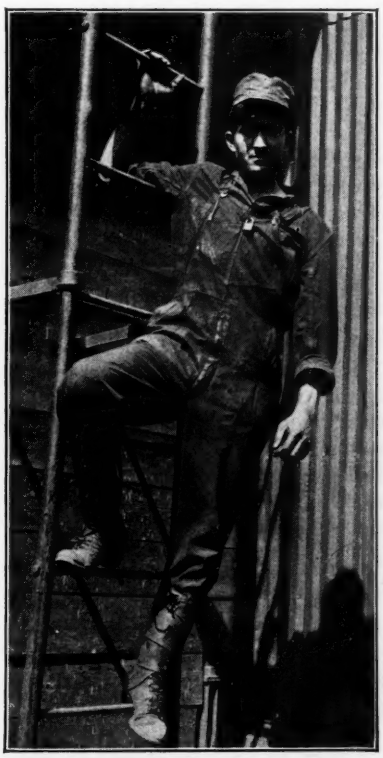


FIG. 3. PERMANENT LADDER AND PLATFORM GIVING SAFE ACCESS TO MACHINERY BEARINGS FOR OILING

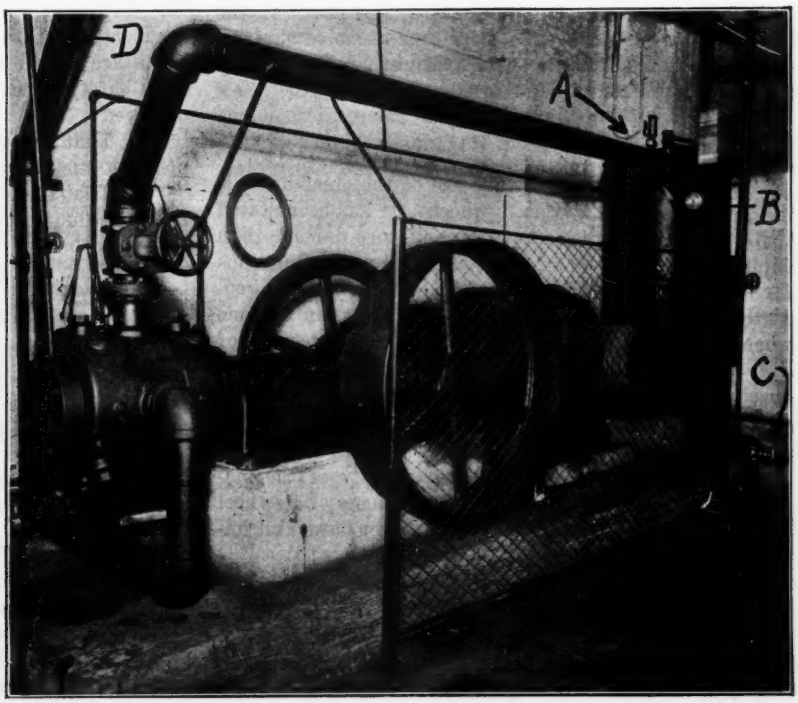


FIG. 4. GUARDED AIR COMPRESSOR AND PROPERLY INSTALLED AIR RECEIVER

Spring pop safety valve at A, pressure gage at B, and drain pipe and valve at C. D indicates the air intake pipe which comes from outside the building where air is cooler. Safety valve should be installed in the air line between the stop valve and the compressor.

Heavy machinery usually is provided with suitable attachment for rings or hooks for lifting or adjusting. To utilize these features to the best advantage and to eliminate possible accidents, the new plant should be designed with eye-beam plates and rings or other permanent attachments suitable for the placement of hoisting equipment to use in working with this machinery.

It is suggested by safety experts that an engine room should have at least two means of entrance and exit which should be easy of access and within reasonable view of the engineer in charge. It is obvious of course that too many entrances would be inadvisable. All passageways and exits should always be free from obstruction and the doors should open outwardly and should not be so close to the operating equipment as to create a hazard. Exits from the basements of the engine room

should be so arranged that there would be little risk of the men being trapped.

In this modern day, the engine room is often the most attractive part of the industrial plant to visitors. If a visitor's gallery is provided, the entrance preferably should be by means of an outside stairway. If the entrance to the gallery is from the main entrance, there should be substantial guards and rails so placed as clearly to prescribe the limits of welcome to the visitors. It is recommended that such a gallery should be rigidly constructed, with guard rails to a height at least of 42 in., with intermediate rails and toeboards, or the space between the top rail and the floor should be entirely filled in. Conversation should not be permitted between visitors in the gallery and engineers or assistants in the room below.

To eliminate the slipping hazard, the floors of the engine room should be of concrete or abrasive surface, or supplemented in approaches to engines and machines by inserts or mats of non-slip material.

Flywheel Hazards

It is generally realized that one of the chief hazards in the engine room is from flywheels. It has been stated that exploding flywheels have caused more damage than exploding boilers. We have state and city regulations for boilers, but there is usually little attempt at the regulation of flywheels. It seems only a question of time when such regulations and laws for the protection of life and property against flywheel accidents will be developed.

There are many possible contributing causes to flywheel accidents. Over-speeding may be the result of an ill-advised attempt to increase the capacity of the machine beyond the safety point. Other causes of flywheel accidents are overloading, failure to detect flaws and improper handling.

Safety of the flywheel depends upon keeping the engine within the predetermined speed limit. Therefore, the utmost vigilance should be exercised to keep the engine in good order and the governor-stop working properly.

Generally speaking, remedies which can be applied for the prevention of flywheel accidents may be among the following:

(a) Better governors.
1. Triple rope drive instead of single belt drive for governor.
2. Governor sheaves to be keyed and the unused portions of keyways to be filled in.
3. Governor sheaves to have suitable guards of substantial construction.
4. Safety cams on all Corliss valve gears.
5. Guards around governors.
6. Governor greasing enclosed in oil-tight covers, readily detachable for inspection.
7. Couplings, set-screws, keys, bolts, etc., in moving parts countersunk.
8. Better care of governors.

(b) Better care of engine parts, belt, etc.

(c) Lower flywheel speed.
1. Two small wheels instead of one large one.

(d) Solid wheels instead of jointed wheels or link jointed instead of flange jointed wheels.

(e) Steel, wood or other wheels adapted to high speeds instead of cast-iron wheels.

(f) Better design of equipment.
1. Avoidance of overload.
2. Arrangement of steam piping to avoid breakage.
3. Avoidance of materials fastened on outside of pulleys or flywheels and avoid holes drilled in such pulleys or flywheels.
4. Locate engines and equipment so that the least possible damage will be done in case of breakage.
5. Space in flywheel pits for broken belts.
6. Signals from engine room to machine room and vice versa.
7. Engine stops.
8. Automatic valves on boilers.
9. Bracing of dangerous wheels with tie rods.
10. Frequent operation and testing.

It has been said that 90 per cent of flywheel accidents are due to a failure of the governor mechanism. As a safety precaution, the following points should be observed:

a. That the governor mechanism works freely and does not stick in any way.

b. That the governor belt is of ample strength, does not slip, due to oil or other cause. Do not use an old oil-soaked belt.

c. That the governor pulley or gears are tight on their shafts.

Frequent inspection of flywheels is important. The failure of a flywheel usually begins by the starting of a minute crack on the under surface of the rim at the point of greatest stress, namely, near the ends of the arms adjacent to the rim joint.

These minute cracks are visible to an experienced eye, and careful inspection will aid materially in the prevention of flywheel explosions.

Safe Lubricating Practice

Development of automatic lubricating devices has been of great value toward the elimination of accidents in the engine room. Following is a list of suggestions, from one of the Safe Practices Pamphlets of the National Safety Council, for the use of foremen in the instruction of oilers:

(a) The clothing worn by an oiler should be close fitting. There should be no ragged ends, torn, unbottoned or loose sleeves, loose or torn trouser legs, long neckties or gloves that might become caught in machinery.

(b) The correct use of ladders and step ladders should be explained, especially as to the correct way of placing a ladder and oiling from it.

(c) The bearings of several countershafts should not be oiled from one position of the ladder.

(d) Step ladders should not be placed astride machinery in motion.

(e) Care should be taken not to walk or stand on machines while they are running.

(f) Idle belts which are hanging about revolving shafting should not be used as supports in reaching bearings.

(g) Reaching over pulleys or between belts is dangerous.

(h) Belts should not be thrown off with hands.

(i) The oiler should be careful not to overflow bearings with oil.

(j) Oil holes in bearings should be kept clean.

(k) The spout of the oil can should be kept clean as particles of dirt might prevent the flow of oil and the result would be dry bearings even though the oiler had supposedly done his duty.

(l) It is very important that the proper lubricant be used for the various kinds of bearings.

Requirements of good machinery guards in the engine room may be summarized as follows:

1. The guard must afford maximum protection.
2. It must not interfere with the operation of the machine.
3. It must be simple in design and construction and the enclosed part should be easily accessible for lubrication, repairs, or other routine changes.
4. It must be durable; strong enough to withstand not only natural wear and tear but also abuse.

Use of compressed air has introduced new hazards that can be eliminated only by proper care in installing, maintaining and operating the compressed air equipment. Many persons have been killed or injured by explosions of air compressors and receivers, and by the introduction of compressed air into the eyes, ears and other openings of the body. It is essential that the air compressor should be installed on a firm foundation, and securely fastened in place. The usual variable load under which air compressors operate represents one of the problems which must be met. This often places an extreme strain on the flywheel and for this reason the air compressor should have a properly protected good governor and it should be inspected frequently.

Exact causes of explosions in air compressors, receivers and pipes are not thoroughly understood, but enough is known to make the best authorities recommend that special attention be given to compressor lubrication, cleanliness of the air at the intake, air cylinder temperature and cooling the air between stages and after compression.

Following are some safety rules for engine rooms which were compiled by a special committee of the A.S.S.E.-Engineering Section of the National Safety Council, in coöperation with a committee of about 75 safety engineers:

(a) Employes should be strictly forbidden to enter the engine room, except for a special mission, and then should remain only as long as necessary.

(b) The engineer should not be permitted to leave the engine room until some other attendant who is thoroughly familiar with the engine, valves and signals, is present to take charge.

(c) No person, other than those responsible for the operation of the engines, should be allowed to touch any valves or other parts of the mechanism, or approach any moving parts.

(d) No one except the attendants should be permitted to go inside the railings, or upon foot-ways, when the machinery is in motion.

(e) The safe speed for each flywheel should be known, and in no case should this be exceeded. Flywheel revolutions should be recorded every day, in order to make sure that the engine is not running over the speed limit.

(f) All parts of engines and accessories should be frequently and thoroughly inspected, and frequent tests, daily if possible, should be made of the governor mechanism and automatic engine stops.

(g) Before getting into an engine or pump, be sure that the flywheel and cross-head are blocked, so that a steam leak cannot start the engine.

(h) Be sure to place danger tag and lock on valves before going into an engine or pump, or to work on machinery, and notify the engineer or operator.

(i) Under no circumstances should engines be started until they are thoroughly cleaned by alternately blowing live steam through each end of the cylinders, and the steam pipe and cylinders thoroughly drained of all water. The drip should be left open, until the load is put on, and then closed. Be sure to warm the engine at both ends.

(j) In shutting down, the drip valve should be left closed until the engine is stopped. If the throttle is equipped with a bypass valve, the throttle should be closed, and engine stopped with the bypass. This gradually stops the engine, avoids the pumping effect of the piston and prevents water being drawn into the cylinder.

(k) Never attempt to "bar" a flywheel around off center, nor pull it off center by grasping the belt, when the steam pressure is on.

(l) Never start to take cylinder head off or piston out of cylinder without making sure that the throttle and exhaust valves are shut tight and locked and the drains wide open; nor without trying the indicator cocks.

(m) Never stop the air pump before stopping the engine (condensing), as the condenser and exhaust pipe may be flooded and overflow into the cylinder.

(n) All steam traps should be kept clean and in working order. Should a trap get out of order, and it be impossible to repair it at once, the bypass should be opened sufficiently to pass off all water.

(o) Leaks in pipes, flanges or gaskets should be repaired at the earliest possible time, but never when they are under pressure.

(p) In opening up a cold line, all available drips should be opened. The line should be warmed by opening the bypass where possible, or by opening the stop valve sufficiently to warm very slowly. Never open the main valve until certain that the line is thoroughly heated. An inexperienced attendant should not be allowed to turn steam into a cold line until properly instructed.

(q) Automatic valves should be frequently examined to insure their proper action in emergency.

(r) Under no circumstances should vacuum-breakers, governors, engine stops or other safety devices be blocked, or otherwise made ineffective. If such apparatus is out of order, it should be repaired at once.

(s) Do not stand in front of cylinder heads.

(t) Do not place any material, tools, etc., on platforms or stairs around engine. They might fall off and injure some one below.

(u) Never work in a gas-engine room alone; always have a helper with you.

(v) If you find a man overcome with gas, get him into the open air at once, send for the doctor, notify the foreman, and start resuscitation by the prone pressure method.

(w) Smoking and open lights should be forbidden around gas machinery and gas pipes; otherwise an explosion might occur.

For Revenue—A Hydraulic Testing Laboratory

VALUE OF TESTING MODELS OF COMPLETE HYDRAULIC TURBINE SETTING IN PRODUCING DESIGN THAT WILL GIVE MAXIMUM REVENUE FOR THE INVESTMENT. BY JOHN S. CARPENTER

IN THIS ARTICLE, it is desired to bring to the attention of engineers several facts in economic design; that is, design for the greatest financial return considering limitations of cost, space and simplicity. With power plants increasing greatly in output per unit, it becomes increasingly important to prove that the sizes and shapes of channels are not too large or distorted for the best financial returns. It is not farsighted, to say the least, to design a large hydraulic turbine setting as

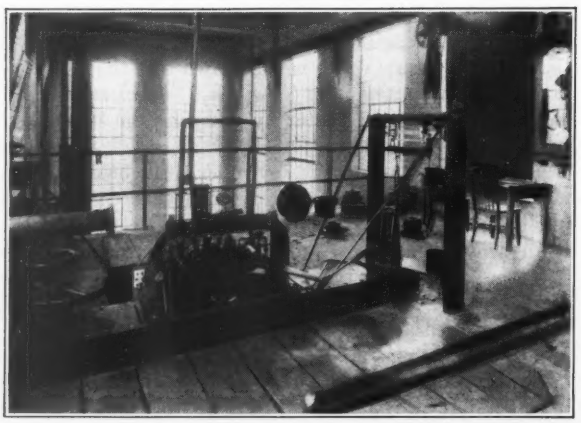


FIG. 1. HYDRAULIC TESTING LABORATORY SHOWING ABSORPTION BRAKE, PRECISION SCALES, GATE OPENING CONTROL, ELECTRIC CLOCK, CALCULATOR

part of an enormous investment, without making tests to determine whether the projected sizes, areas and transitions cannot be improved upon as regards output for the available cost.

The writer has in mind half a dozen sizable water power plants in which great savings could have been made on the first cost with increased income in the form of revenue. Every water power plant is a law unto itself, for there is almost an infinite variety of conditions possible as regards head available, location of setting as affected by structural requirements, length of channels as affected by structural limitations, length and curvature of draft tube as affected by excavation, character of foundation, draft head allowable, to say nothing of inlet characteristics of the scroll case such as curvature, relation of height to width, relation of width to size of turbine speed ring and the like.

MULTIPLICITY OF FACTORS COMPLICATES DESIGN

With such a great number of combinations, few engineers will presume to say, given all the limitations enumerated, that they can design a turbine setting, including scroll case, entrance channels and draft tube, that will represent the maximum of output as reflected in annual revenue with the minimum of cost, without recourse to model tests.

Too little is known as yet regarding entrance and discharge channels to allow a final statement as to the best velocity relations to be adopted in a new plant. If all plants were of one specific speed, one head, had standard conditions of entrance and discharge, we could state definitely the proper velocities for the point of design. As they are not, no manufacturer can give these final data without an enormous fund of test data. The infinite variety of plant conditions make it scarcely possible that such data would be on hand for a given case picked at random.

It is one thing to develop a highly efficient scroll case and a satisfactory draft tube, doing it individually. But the final check on any given design is to test it in model size in combination with the structural parts with which it will operate. This can be done easily and dependably in model size at surprisingly low cost. The scroll case, the turbine and the draft tube must be reproduced in model size and then reliable data are available whereby plant performance can be accurately predicted. Flood conditions, high tailwater conditions, low water conditions can be just as easily reproduced as the normal

FIG. 2. MINIATURE TURBINE SETTING FOR TESTING MODEL DRAFT TUBE FOR VACUUM, HEAD REQUIRED TO DISCHARGE GIVEN WATER QUANTITY AND COMPARATIVE EFFICIENCY. ILLUMINATED WINDOWS AND RIBBON STREAMERS SHOW FLOW CONDITIONS AND ARM CAN BE PASSED INTO STREAM TO FEEL FOR WHIRLS AND POCKETS OF DEAD WATER

flow stage. Modifications in the scroll case or the draft tube can be made in a short time, which in the full-sized plant would cost perhaps hundreds of thousands of dollars and take months of valuable time that might otherwise be utilized for revenue. Models can be changed at so little cost that to enlarge, make a bend in or reduce the size of a channel is very simple and comparative results may be found for different conditions.

There comes to mind a case in which the unit capacity was increased nearly 50 per cent above what was thought good practice merely by developing a setting wherein all the component parts were suited to each other and the most harmonious combination gave 92 per

cent efficiency; yet the scroll case and draft tube velocities were extremely high since all that water had to be crowded through the space available. This case is no exception. Frequently, scroll cases that were highly esteemed by their creators have shown greater unit output and efficiency after certain changes were made. The same applies to draft tubes.

VALUE OF TESTING COMPLETE ASSEMBLY BY MODELS

It is not always true that a highly efficient scroll case and a highly efficient draft tube will, in combination, give to an efficient hydraulic turbine the maximum of revenue-producing effect. The matter of specific speed enters, in that discharge rotation varies greatly with contemporary specific speeds and a draft tube that will work exceptionally well with a given turbine of given

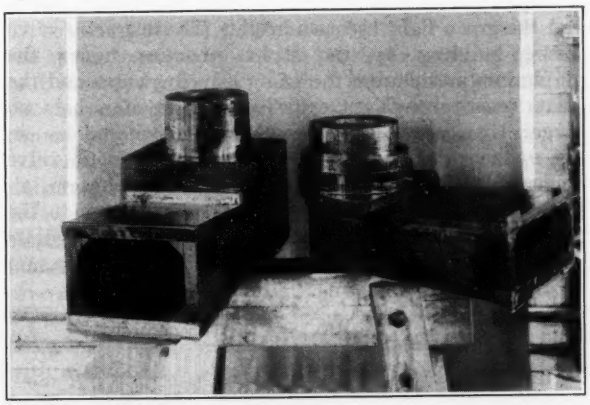


FIG. 3. TWO MODEL DRAFT TUBES, INEXPENSIVELY BUILT OF PATTERN LUMBER AND WATERPROOFED

specific speed will not produce satisfactory results with another turbine of materially different specific speed.

The most economical point to operate such a water turbine is not necessarily at the maximum point of efficiency of each component part. Such a point can only be found when the ensemble is tested together, so that the weighted importance of each part is found in combination with the other elements. In other words, it is a case of maxima and minima which cannot be found by calculus. We do not know enough about the variable quantities and the laws upon which they depend to state t roblem in symbols, equate the expression to zero and solve the remainder. The only remaining solution is to test the ensemble under a variety of heads and points of load, which will then give data so that a contour curve sheet can be plotted. The dependable results for any operating condition can then be picked off in short order.

Union Carbide and Carbon Corp. Power Plant

CONSTRUCTION WORK is now under way on new hydroelectric and steam electric power plant developments of subsidiary companies of Union Carbide and Carbon Corp., in the vicinity of Hawks Nest, Gauley Junction and Boncar, W. Va. The total installed capacity of the two plants will be about 200,000 hp. Power output will be utilized by the proposed industrial plant of Electro Metallurgical Co. at Boncar. The hydroelectric development is being built by New-Kanawha Power Co. and is located on the New River, between Hawks Nest and Gauley Junction. It will consist of a dam across New River, an intake, a power tunnel, surge tank, steel penstocks and power house.

The dam will be built a little less than a mile below Hawks Nest Station of the Chesapeake and Ohio Railway. It will be about 826 ft. long between abutments and will raise the water of New River about 60 ft. above low stage at the dam. From the pool above the dam, water will be diverted into penstocks by an intake tunnel, the tunnel being about 16,250 ft. long and 30 ft. in diameter. The penstocks will connect with the hydraulic turbines and power station. At about mid-length, the tunnel will be provided with an intermediate surge basin and at its lower end with a surge tank of large dimensions.

The power house will contain four units, each rated at 35,000 hp., a total installed capacity of 140,000 hp. From the power house, a transmission line will run a distance of about six miles to the industrial plant at Boncar where a power connection will be made with the proposed steam electric power plant. It is estimated that an annual average of over 80,000 hp. will be delivered to the Boncar industrial plant from the hydroelectric station.

Contract for the construction of the dam, tunnel and power house was let to Rinehart and Dennis Co., Inc., on March 13, 1930, and work was commenced on March 30. Completion is required and the entire development is expected to be ready for operation by March 13, 1932.

The steam electric power plant is being built by West Virginia Hydro-Electric Co. on the Kanawha River immediately adjacent to the site of the industrial plant at Boncar. It will consist of two steam turbine-generator units, each with a capacity of 22,500 kw., a total capacity of 45,000 kw. or 60,000 hp. This plant will even out the irregularities of power supply which naturally occur in a hydroelectric power plant situated on a stream where the flow is not regulated. Contract for the design and construction of the steam electric power plant development was let to Ford, Bacon and Davis, Inc., on April 15, 1930, and it is expected that it will be finished about July 1, 1931. Hydroelectric and steam electric plants are expected to provide an average combined output of about 120,000 hp.

O. M. Jones, Chief Engineer of New-Kanawha Power Co., who is located at Glen Ferris, W. Va., is in local charge of the hydroelectric and steam plant installations for L. H. Davis, 30 East 42nd St., New York, N. Y., vice-president of New Kanawha Power Co. and West Virginia Hydro-Electric Co. E. H. Mangen is resident engineer in charge of the industrial plant installation for H. L. Noyes, chief engineer of Electro Metallurgical Co., who is located at Niagara Falls, N. Y. Contracts for the erection of the first block of industrial plant buildings has been let to H. B. Agsten and Sons of Charleston, W. Va.

TOO MUCH lubricating oil used in an internal combustion engine will tend to promote an accumulation of carbon, especially where the cylinder temperature may be high and where there is a possibility of the excess oil being burned to free carbon.

Regulating High-Pressure Heating Steam

STEAM FROM a central heating plant is piped and regulated to our buildings as shown in Fig. 1. The steam goes through a meter to the first reducing valve

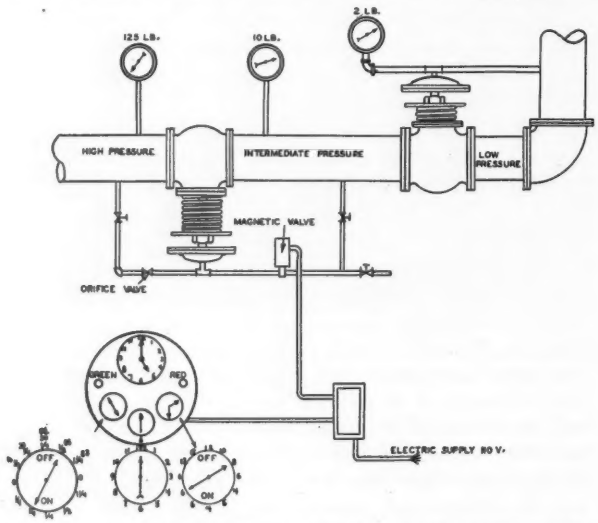


FIG. 1. ARRANGEMENT OF REDUCING VALVES AND PRESSURE CONTROL APPARATUS

at 125 lb. pressure and is reduced to 10 lb.; then it passes through a second reducing valve to the heating system at 2 lb.

After the building is warm, the dials on the clock are set for intermittent service, depending on the outside temperature. The setting of the center dial is the same as that of the clock, and dial and clock move together.

The left-hand dial is used for day heating and may be set for any desired condition within the ranges shown. As illustrated, it is set for ½ off and ¼ on, or 66 per cent, which would mean 40 min., or 33 per cent off and 20 min., or 66 per cent on. The right dial is for night heating. It shows the times at which the steam is cut off entirely and when it is turned on again. As shown, it is set for 8 p.m. off and 6 a.m. on. After it is turned on, the steam periods follow the setting of the day heating dial at the left. The No. 3 position on the right dial is for conditions where steam is to be cut off at 12 o'clock noon and come on again at 4 p.m. The red and green lights show whether steam is on or off the system.

As the clock hands move around, the switch opens and the green light becomes bright. The magnetic valve closes, building up the street pressure under the diaphragm and closing the main reducing valve and the steam goes through an orifice consisting of a hole no bigger than a pin point. When the switch goes on again, the red light brightens and the magnetic valve opens, releasing the pressure under the diaphragm, allowing the main valve to open and admit steam to the heating system. It is regulated by the intermediate pressure. The low-pressure valve reduces the pressure from 10 to 2 lb. pressure.

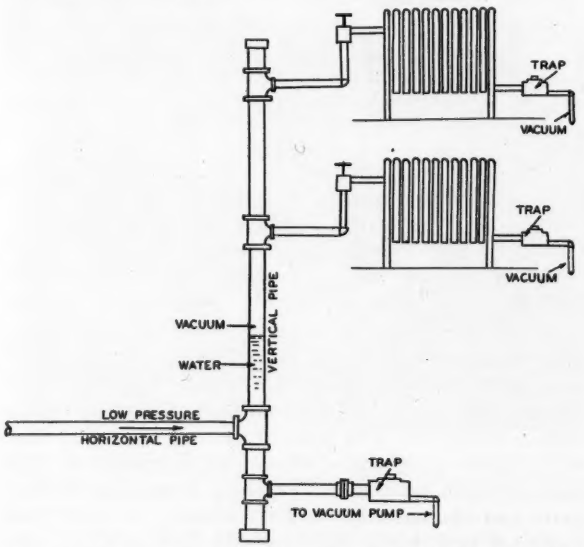


FIG. 2. RISER AND CONNECTIONS SHOWING HOW WATER OF CONDENSATION BUILDS UP

Some building managers say they can save steam by lowering the pressure in the system to say ¼ lb. and keep the steam on continually during working hours, instead of carrying a higher pressure and work it intermittently on and off with the clock. It is known that the water of condensation will build up in vertical risers as shown in Fig. 2, vacuum at one side and low pressure at the other, forcing the water away from the vacuum trap at the heel of the riser. If the steam is shut off for only a few minutes, the water drops back and goes through the vacuum trap.

New York City. THOMAS SHEEHAN.

Simple Commutator Troubles Often Caused by Neglect

As one example of how an apparently easily detected commutator trouble will often mislead the operator into believing that his difficulty is caused by a defect not at the commutator, an experience that I had while calling on an operating friend is interesting. He looked for winding troubles as a cause of poor commutation, when the trouble actually was caused by the entire set of brush springs, which had been in use so long that their elasticity had nearly disappeared.

This permanent set in brush springs may also be caused by giving the brush rigging so little attention that the pig tails cease to carry current, this duty being transferred to the brush springs, which become heated occasionally when there is a heavy load on the machine. This heating draws the temper out of the springs. If the spring tension behind the brush does not act quickly and constantly in maintaining the brush pressure on the fast moving commutator bars, good commutation cannot be expected, of course.

I have observed many generators where the brushes underneath the commutator have had little attention because they were hard to get at, although thorough cleanliness of all the parts that comprise the brush holder is essential. As an aid in cleaning commutators, several non-inflammable liquids are on the market that have all the grease-absorbing characteristics of benzine but none of the fire hazards. These liquids may be used with a stiff clean paint brush to wash the dirt and accumulated grease from the brush-holders, thus maintaining a free movement of the brush-holder parts so that everything will be in readiness to handle the peak load demands on the machine.

Collector rings usually are so free from troubles that the glaze on them is frequently unnoticed, but I have observed alternating-current slip-ring motors connected to intermittent start-and-stop apparatus, like elevators, where the removal of the glaze from the rings reduced the time of acceleration 40 per cent, thus saving considerable power and adding to the efficiency of the apparatus as a whole. It pays to watch commutators and slip rings carefully.

Hobart, Ind. Harry J. Achee.

Unequal Expansion Deflects Long Shaft

Some time ago, a synchronous condenser unit was installed, consisting of the condenser proper with a starting motor mounted at one end on an extension of the shaft. Two main bearings were provided on the condenser and an outboard bearing for the shaft extension on the starting motor. During the dry-out period, the unit was run by means of the starting motor and warm air was supplied to the main machine. After a few hours' run, it was shut down to allow taking the temperature readings. The unit was then started again and the process repeated, each cycle consisting of about 4-hr. running time and 1-hr. shutdown.

After a few cycles it was noticed that, on starting up the unit, the end bearing bracket on the starting motor was weaving and a check showed the shaft running about 1/32 in. out of true at the outboard motor bearing. Yet, during the 5 min. required to bring the unit up to speed, the eccentric action disappeared and the shaft ran true. While the unit was being shut down, the shaft continued to run true until it was completely stopped but, on starting up again, the same eccentricity appeared.

Some jumped to the conclusion that the shaft was being deflected by the weight of the main rotor during the shutdown period but it was difficult to reconcile this conclusion with the fact that after two or three minutes' running the shaft ran true.

Investigation was made by mounting a surface gage from a support on the floor with a bearing against the end of the shaft, so as to indicate the amount of eccentricity. By carefully watching this gage during the shutdown period, it was observed that, as soon as the unit came to a standstill, the shaft end began to deflect downward and continued to do so for several minutes. This deflection was in the direction opposite from that which would be expected, if it were due to the weight of the rotor. An analysis of the action was made and on the next shutdown, cooling water was cut off from the main bearings before the machine came to a standstill. This time the surface gage indicated no shaft deflection and when the unit was started up; the shaft ran true.

To confirm the idea that uneven shaft temperature was at the root of the difficulty, the unit was again shut down with the water cut off and, after it had stood still for several minutes without any deflection being indicated by the surface gage, water was turned on. The shaft immediately began to deflect downwards.

Cooling water is applied only to the lower half of the bearings, thus cooling the lower side of the shaft and causing the end projecting through the starting motor and to its outboard bearing to bend down. When the machine was started, the rotation of the shaft soon brought it to a uniform temperature and straightened it out. The experience gave a rather startling and forcible illustration as to what can happen to a long shaft which is unevenly heated.

Chicago, Ill. James Brinn.

Emergency Repairs to Mill Motors

An unusual break-down was experienced on an 850-hp., 2300-v., wound-rotor, slip-ring motor, which is used with a liquid slip-regulator. This particular motor operates a set of rolls on a blooming mill and, after being idle over the week-ends, is subject to a heavy starting load as the lubricant in the large reduction gear case becomes thick. On starting up on Monday night a few weeks ago, there was a serious flash-over between the two outside slip-rings. Inspecting the rings revealed that the terminal stud in No. 1 ring was almost entirely burnt off at a point of entering the ring. The terminal stud for No. 3 ring was shorted solid to No. 1 ring where it passed through this ring.

Speedy and economical repairs were made by the following procedure: The rotor winding leads to No. 1 and No. 3 rings were disconnected. The copper terminal stud for No. 1 ring was sawed off close to the ring and a 1¼-in. hole was drilled and tapped in the ring. A new copper stud was turned in a lathe and threaded for 1¼ in. on one end. The opposite end was made the same as the original stud so as to take the lead from the rotor winding. The new stud was screwed into

the ring and soft soldered to prevent it from loosening and thus making poor contact.

After chiseling the burnt beads from the No. 3 stud and No. 1 ring, what remained of the burnt insulating bushing was removed. The brass ferrules were then sawed from a 100-amp., 600-v., renewable fuse casing and the casing was reamed out slightly and fitted over the stud. The ring assembly was then blown with compressed air and cleaned with carbon-tetrachloride. It was then given one coat of quick air-drying insulating paint. The rings were then tested for resistance and showed 50 megohms between rings and the same resistance between each ring and ground.

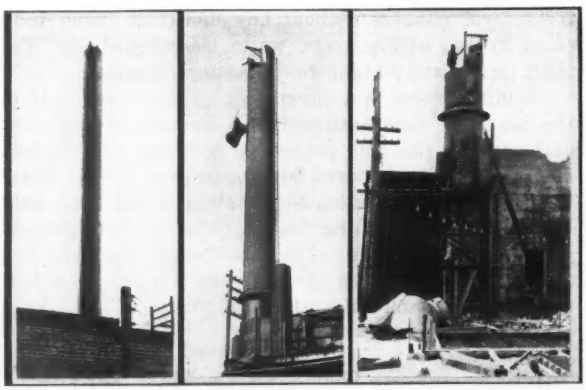
The rotor windings were then given the same test and proved to be in good condition. After these tests, the rotor winding leads were connected to the rings and the motor was put back on the line. It has been running fine ever since.

Phillipsdale, R. I. W. D. Bristow.

Cutting Torch Aids Stack Dismantling

Taking down a high metal stack, especially in a location which precludes dropping it, may be almost as big a job as assembling it.

Sections of the stack shown in the illustration, which was 5 ft. in diameter and 140 ft. high, were cut rapidly



PIECE-MEAL WRECKING OF 140-FT. STACK BY MEANS OF CUTTING TORCH

and lowered to the ground by means of the pole with its boom which was erected in the center of the stack. Pole and boom followed the scaffolding on the inside of the stack to the ground as the height of the stack was reduced.

Missouri Valley, Ia. Frank Bentley.

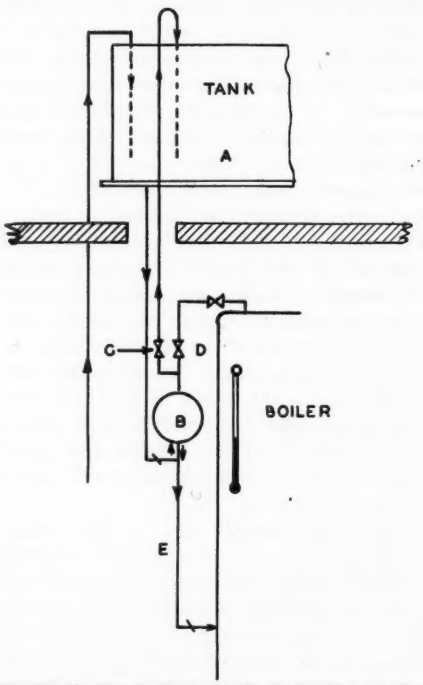
Novel Boiler Feed and Water Regulating Device

Some considerable time ago, wire nails, from the smallest brad to the biggest spike, were manufactured in a certain country machine shop operated by the owner and one apprentice. Also the town's machinery in general was repaired. Inertia was absolutely unheard of in that shop. As in the majority of shops at that time, a small boiler and engine furnished the power and it fell to the lot of the apprentice to keep the boiler boiling and the engine engining!

This particular apprentice was more inclined toward engineering than toward nail making and spent the major part of his time in the steam plant, thus reducing the efficiency of the nail plant. As it was the nail plant that paid the dividends, the master mind was sore put as to the outcome, until an idea entered his head.

Hard coal was the fuel, a small blower being used after each firing to start the fuel into action. A damper regulator controlled the draft and no trouble was experienced with the fire for an hour and a half at a time. It was the water that bothered! The apprentice spent 40 min. out of every hour watching and adjusting the water!

By tying a string on the glass and noting that, with the feed shut off tight, the water line would drop approximately 1 in. in 3 min., the machinist determined



ARRANGEMENTS OF TANKS AND PIPING THAT AVOIDS FLOODING BOILER

how fast water was used. He did not figure the cross section of the vertical boiler and deduct the tube area as the modern engineer might do. He waited until Sunday, then poured measured water through a funnel into the feed line and discovered that 3 gal. raised the water just 1 in., which, to say the least, was a satisfactorily accurate way to ascertain the fact!

A plunger pump forced water through a home-made trombone-coil heater directly into the boiler. The owner seemed to have no fear of low water but dreaded high water intensely as an engine at one of the factories had been wrecked through this latter cause.

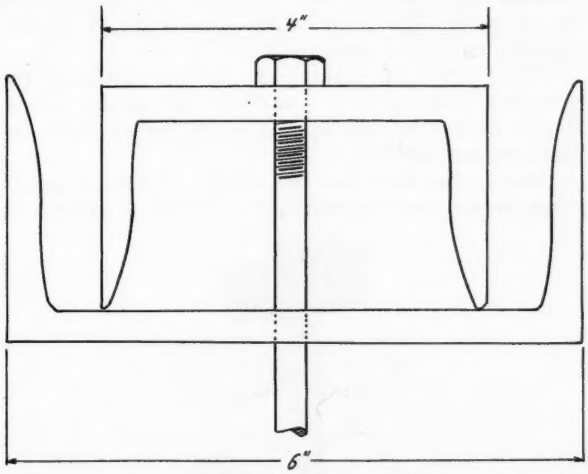
He proceeded to make a satisfactory feeding device and water regulator as shown diagrammatically in the sketch. Warm water enters tank A and flows to an auxiliary tank B when vent valve C is open and steam valve D is closed. When vent valve C is closed and steam valve D opened, through the medium of a cam shaft operated at specific intervals, water flows from A through pipe E to the boiler. By this method, the boiler cannot be flooded.

Lawrence, Mass. C. J. Wilder.

Buckstays

OCCASIONALLY a cast-iron buckstay will break while in service in a horizontal return tubular boiler. The usual practice, under such a circumstance, is to order a new one from the boiler shop or to make a pattern and have a new buckstay cast in a local foundry but there is a better way. Procure a piece of channel steel, 5 or 6 in. wide, according to the length of the buckstay, drill a couple of holes for the cross-rods and substitute the channel for the broken stay.

In case the boiler is very large and is set high above its grates, a wider piece of channel steel may be necessary to provide the required stiffness in a very long buckstay. In such a case, instead of using 8 or 10-in. channel beams, put a 4-in. channel inside of the flanges of the 6 in. one. If the narrower channel be turned with its flanges inward, toward the wider channel web, then there will be a wide, smooth seat for the stay-rod nuts and since the web of the narrower beam is then in tension, greater stiffness is obtained than when both beams are placed with their flanges outward.



CHANNELS USED AS SHOWN FORM RIGID AND CONVENIENT BUCKSTAY CONSTRUCTION

Cast-iron buckstays are usually slotted at their ends but this is hardly necessary when channel buckstays are made. In erecting a new boiler setting, a slotted stay enables the rods to be laid upon a course of brick an inch or so too high or too low and the slots will permit the rod to enter the buckstay properly. If desired, the channel stays can be slotted with very little trouble; simply lay off and drill a row of holes, then chisel the holes into a slot with a cold chisel or broach and a sledge hammer.

Some buckstays are set directly in the boiler room floor. This is poor practice. Buckstays always develop more or less movement, vertically, horizontally and laterally, causing the concrete to spall or become pulverized around the buckstay, thus developing a hole around the floor end. It is preferable to place the buckstays level with or slightly above the boiler room floor, whenever possible.

Do not be too sparing of buckstays. Two pairs are insufficient save for the smallest size boilers and three pairs are too few for the largest ones made. In locating buckstays, while setting a new boiler, pay attention to the blueprints. If the drawings show the buckstays located fair with the lugs which support the boiler upon the brick work, well and good. But, if the stays are not so located on the blueprints, then take up the matter with the boiler manufacturer and if he does not see fit to correct them, you will be warranted in changing the location of the buckstays so as to make them come fair with the lugs which support the boiler.

A certain boiler setting cracked and bored at the rearmost buckstay and the owner "came back" at the writer for having located that pair of buckstays improperly. The boiler was blocked up, the rearmost part of the setting torn down until solid brick work was reached and then rebuilt. In doing this work, the cause of the trouble was discovered and remedied. The boiler owner, who had supervised the boiler setting, had caused the steel rollers under the rear lug, to be placed lengthwise instead of crosswise of the boiler setting walls; hence the expansion of the boiler shell, which was thus fixed at both ends, simply carried with it the rear end of the setting and made the break at the lug plates, where the buckstays were properly located.

If, before putting the nuts in place on the buckstay cross-rods, you liberally daub the threads with a mixture of powdered graphite and oil, you will never be sorry. In years to come, it will then be possible to remove the nuts without having to heat them almost red hot with a blow torch. Furthermore, before quitting a buckstay job, use a hack-saw on the projecting stay rods and cut them off flush with their nuts.

Indianapolis, Ind. JAMES F. HOBART.

Solution to Make Drill Point Bite Into Tempered Steel

WORKERS in steel often find it desirable to bore holes in parts of machines that have been tempered. By using the following solution on the drill point, a hole can easily be bored through a tempered steel spring or other machine part. Make up a strong solution of camphor in turpentine, shaking the bottle until the camphor is dissolved. Put the drill on as slow a speed as possible and keep the cutting edge continually wet with this solution.

The camphor may be readily dissolved in a small quantity of alcohol and then added to the turpentine.

Hobart, Ind. HARRY J. ACHEE.

Baffles the Chief

HERE IS THE PRIZE of my experience. Two 500-hp. vertical bent-tube boilers were taken down when a certain plant was shut down and all equipment was sold. The boilers were shipped several hundred miles and set up again. When they were fired up and load put on it was found that they couldn't keep up steam. The owners had sent for an expert from another plant but he had not arrived yet. I chanced to visit the plant and found the chief (!) about to start some laborers cleaning up a "pile of old brick that were shipped in with the rest of the junk." Well, the "old brick" were the baffle tile. 'Nuff sed.

Minneapolis, Minn. FRED S. RUTLEDGE.

Questions and Answers

Furnace Construction for Natural Gas

RECENTLY natural gas has been piped to our city and I would like to know what changes would have to be made to a hand-fired water-tube boiler to use the gas for heating the boiler and what kind of burner is used?

H. A. M.

A. It is likely that little change need be made in the furnace proper except to install the burner in the firing door and to install brick checkerwork as shown in Fig. 1.

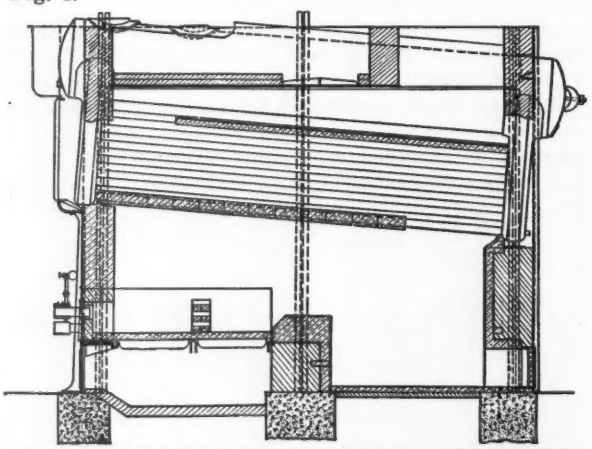


FIG. 1. TYPICAL NATURAL GAS BURNING SETTING WITH HORIZONTAL BAFFLES

Design of a boiler furnace for burning natural gas involves several important points. First, the furnace volume or combustion space must be so proportioned that the gases will not come into contact with the cool heat absorbing surface until combustion is completed. A furnace volume of about 2 cu. ft. per rated horsepower will give sufficient combustion space to meet the above conditions.

With horizontal baffling on the lower tubes, as shown, the furnace volume would be well adapted for changing to natural gas burning. Dutch oven furnace construction may be necessary under other circumstances. Second, in order to prevent laning action of the gases in their passage through the boiler it is more desirable to use a large number of small burners than a few large ones. One burner for 25 or 30 rated boiler horsepower will give satisfactory results. Third, where furnace widths are over 5 ft. it is desirable to install checkerwork to act as an igniter for the gases. In some cases one checkerwall placed about 3 or 4 ft. from the burner outlets is used as an igniter and a second checkerwall, about 3 or 4 ft. behind the first, acts to break up the flame and mix the gases thoroughly after passing the first checkerwall.

A burner specially designed for natural gas is shown in Fig. 2. This consists of outer and inner casings and a nozzle. Into the inner casing is driven a large number of small brass spuds which are drilled half way through in two directions. These two holes meeting, form a passage for the gas from the annular space between the outer and inner casings into the inner cylindrical space. Here the gas is introduced in a great number of fine jets into the air which is drawn through the burner. Air regulation is accomplished by adjusting the front slide. This type of burner operates under low gas pressure.

Other types of natural gas burners utilizing gas pressures, ranging from 5 to 20-lb. per sq. in. for inducing their own combustion air, are also available for high pressure service.

Due to the fact that the supply of natural gas is often erratic and uncertain, the custom is general to install the burners above coal fired grates or stokers. The grates or stokers normally are completely covered with firebrick so that should the gas supply fail, the bricks can be removed easily, the burner swung out of position and a coal fire started quickly.

FIG. 2. SINGLE BURNER FOR NATURAL GAS SHOWING HEADER CONNECTION

Flow of Steam in Pipe

HOW IS THE AMOUNT of steam conveyed in a long pipe computed? I have a 5-in. pipe 400 ft. long; the steam pressure is 35 lb. gage and the drop in pressure is 2 lb.

A. S.

A. Kent gives the following formula for flow of steam in pipes:

$$W = c\sqrt{w\,(p_1-p_2)\,d^5 \div L}$$

in which W = weight of steam in pounds per minute.
c = coefficient of discharge
w = density of steam in pounds per cubic foot

$p_1 - p_2$ = drop in pressure in pounds per square inch
d = inside diameter of pipe in inches
L = length of pipe in feet

From a table (Kent, p. 928) of values of c for standard sizes of lap-welded pipe, c for 5-in. pipe is found to be 66.5.

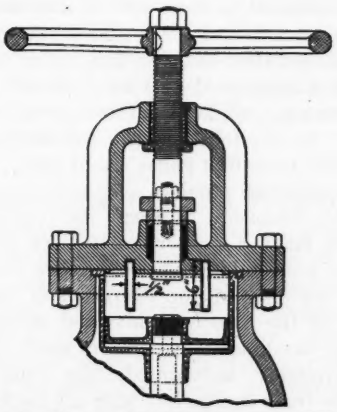
From steam tables, the density of steam at 35 lb. gage or 50 lb. abs. is found to be 0.1175 lb. per cu. ft.

Then $W = 66.5 \sqrt{(0.1175 \times 2 \times 3125) \div 400}$
$= 66.5 \sqrt{1.836}$
$= 66.5 \times 1.36$
$= 90.44$ lb. per min.

Overcoming Nonreturn Valve Chatter

REFERRING to the article on page 775 of the July 1 issue on valve chattering, I have had a similar experience with the same type of valve which had been installed on a new boiler. The boiler primed badly which may have been one of the causes of chattering.

After three months' service, the valve chattered badly. At first we kept screwing down on the valve



VALVE CHATTERING PREVENTED BY PINS ATTACHED TO UNDER SIDE OF VALVE BONNET

wheel until the chattering stopped; later we put in two pins ½-in. diameter and 6 in. long under the valve bonnet as shown in the illustration. These kept the valve from opening wide and prevented chattering. Since the boiler had a steam heating load, there could have been no "pulsations."

New York City THOMAS SHEEHAN.

Thermal Efficiency of Steam Engines

HOW ARE THE heat and thermal efficiencies of a steam engine computed?

2. An engine operates at 325 lb. gage pressure and exhausts into a 28-in. vacuum. What is the heat efficiency?

3. An engine operates at 100 lb. gage pressure and exhausts at 4 lb. back pressure. What is its heat efficiency? A. A. S.

A. "Heat efficiency" is a common term given to the more generally used technical term "thermal efficiency". They mean the same thing.

Thermal efficiency of a steam engine is the ratio of the heat equivalent of the work done to that supplied, measured above the heat of the liquid at exhaust pressure. Heat equivalent per horsepower is the number of B.t.u. or heat units corresponding to work equivalent to 1 hp.

Thermal efficiency may be expressed as indicated, brake or combined thermal efficiency, depending upon whether the work done is based upon the indicated load, brake load or combined output of engine and generator, respectively. Since the heat equivalent of 1 hp. is 2547 B.t.u. per hr., the indicated, or brake thermal efficiency, E, may be expressed: $E = 2547 \div W (H - q)$ where W = pounds of steam per i.hp-hr. or br.hp-hr. and H = total heat in the steam at the initial pressure in B.t.u. per lb. as found in steam tables and q = the heat of the liquid corresponding to the exhaust pressure in B.t.u. per pound as found in steam tables.

If the combined thermal efficiency of the engine and generator is desired, the heat equivalent of 1 kw., which is 3415 B.t.u. per hr., must be used and the water rate W must be taken in pounds of steam per kilowatt-hour. The equation would then read:

$$E = 3415 \div W (H - q)$$

2 and 3. Since you give neither the condition nor amount of steam, we will assume the steam to be dry and saturated, in which case we take our data from saturated steam tables and we will assume the water rate or steam consumption to be 9 lb. per hp-hr. in the first case and 12 lb. in the second. Since the barometric pressure was also not stated, we will assume it to have been 30 in.

Therefore, the indicated or brake thermal efficiency for the first case will be:

$E = 2547 \div W (H - q)$

325 lb. gage = 340 lb. abs. pressure

Steam tables give the total heat, H, at this pressure to be 1205.1.

If the barometric pressure were 30 in. and the exhaust pressure, 28 in., the absolute pressure at exhaust would have been 30 — 28 = 2 in. of mercury. This corresponds closely to 1 lb. abs. pressure and the heat of the liquid, q, at 1 lb. pressure as given in steam tables is 69.8 B.t.u.

Therefore $E = 2547 \div 9 (1205.1 - 69.8) = 25$ per cent.

For the second case

H at 100 lb. gage or 115 lb. abs. = 1188.8, and

q at 4 lb. gage or 19 lb. abs. = 193.4

In this case, the water rate of the engine will undoubtedly be greater than in the former case because of the less favorable steam conditions; hence we have assumed W to be 12 lb. per hp.-hr.

Then $E = 2547 \div 12 (1188.8 - 193.4) = 21.3$ per cent.

If the assumptions made are not correct, as indeed there is little likelihood that they are, you can substitute the actual figures for those assumed and make the necessary arithmetical calculations.

HIGH VOLATILE coals require less air through the fuel bed and more air over the fire than the low volatile types, so that for good combustion the draft loss through the fuel bed will vary with the kind of coal burned.

IN TURBINES, there is a definite ratio of bucket velocity to steam jet velocity that gives the best economy.

Editorial Comment

Gaining Wider Knowledge

One of the limitations of management as outlined in a recent management convention was too little knowledge of new equipment and the seemingly concerted effort by some companies to prevent subordinates from acquiring it. Although the statement was made in connection with the manufacturing department, there is perhaps no department in an average industrial plant to which the statement could be better applied than to the power plant.

This lack of knowledge can be corrected in three ways: by conventions or inspection trips to other plants, by salesmen and by magazines. To be fully effective, all three methods should be used although the use of any one of the three will result in improving conditions. The first is expensive both in the matter of time and traveling expenses. The second should, however, be available to the majority of those in responsible positions, while the third is denied to no one, regardless of rank or position, unless he himself refuses to take advantage of it.

Practically all manufacturers have salesmen calling periodically at all industrial plants. These men are usually well trained, familiar with their business and only too glad to explain in detail the equipment which they sell. Often they can tell of novel or unusual applications in other plants or other industries and suggest valuable improvements. These suggestions do not have to be followed but they do add to the general store of knowledge, often proving valuable to the engineer who does the original thinking.

Some companies make it a point to see that these representatives have ready access to men in responsible charge of operation, others make it a point to hedge the plant operators about with such a wall of red tape so that it is impossible to reach them, while still others shunt the salesman off on the purchasing agent, a practice which may be good or bad, depending on the purchasing agent himself.

Of necessity, personal contact by sales representatives is limited, both because of the sales expense to the manufacturer and the limited time which any man in a responsible position can devote to these men and still take care of his duties.

This leaves an extremely valuable part for technical magazines and trade papers to play in the industrial development of this country. Their influence extends not only to those at present in responsible positions but should extend down the line to those younger men who today are playing a minor part but tomorrow will be promoted to responsible positions. The cost is insignificant; the saving effected will in itself pay the cost of the service many times over.

Not only is the current practice of their own industry made available to readers but practice in other industries is emphasized. New developments are placed before them both in the advertising and editorial pages in a convenient manner so that they can make it a point to get in touch with the manufacturers of equipment in which they are especially interested, thus making it unnecessary to spend many hours with representatives of firms in whose product they have no direct interest, a saving of not only their time but the salesman's as well.

Observation Pays

In the Letters Section of this issue an engineer described how he found the cause of shaft deflection on an electrical unit in his plant to be due to unequal heat expansion. His analysis of the conditions observed and his method of arriving at the correct solution of the difficulty are not only interesting but should stimulate others to observe more closely the operation of the equipment entrusted to them and to analyze conditions that are not normal.

Improper operation may be detected in many ways. Sometimes a change in the sound given off or the production of an odor, slightly different from that usually present, may be the telltales that will indicate trouble. Indicating and recording gages are of much aid in such detection of potential trouble.

After the discovery of some mal operation, it is important to make a proper analysis of the difficulty involved and such analysis is based upon the observer's knowledge, not only of the operation of his own machinery but of the principles involved in the operation of all similar machinery. Operators need, therefore, to become thoroughly acquainted, not only with the machinery in their charge but with all machinery in its class and managers should provide time and opportunity for their operating forces to acquire this necessary knowledge.

Adequate analyses are rarely made under stress of action or under conditions burdened with details which lie outside of the field of operation.

Prevention of trouble and of wear is more important than repair and is much less costly. Observation, analysis of conditions and results make for methods of operation that will aid in such prevention.

Industrial Heat Balances

Heat balance of the entire steam cycle of an industrial plant will certainly prove as valuable to the engineer of the plant as it does to the central station engineer. Too many industrial power plant engineers tend to think of the heat balance as something extremely highbrow, difficult to lay out, involving a knowledge of thermodynamics and, in general, of use only in connection with large steam and power generating units.

This is an erroneous idea, of course, for the heat balance is nothing more nor less than a fairly simple diagram showing how much heat is available in the fuel and what becomes of it in the plant. While the heat balance often shows only the power plant itself,

there is no reason why it cannot also show the entire distribution of heat throughout all the processes. It may mean considerable trouble to get it for the whole plant but that trouble is well repaid by the complete information that will be obtained and the feeling of confidence it will engender in the engineer.

Some instruments are necessary, of course, with which to obtain the required data but not nearly so many as one might suppose. Wonders can be accomplished with a portable steam flow meter, a few thermometers and the exercise of a little ingenuity.

Elsewhere in this issue, E. F. Sibley discusses the heat balance of the modern laundry. A careful study of the way in which the entire installation is analyzed will repay every industrial power plant engineer. As he has pointed out, the engineer must remember that the attempt to prevent heat losses should take into account the cost of making the saving.

In the modern laundry, the increasing use of power-driven machinery necessitates a more accurate analysis of the balance between steam and power to determine methods for using all the excess steam throughout the year instead of only in the winter. But the principles brought out by Mr. Sibley apply equally well to many other industries. Use of the heat balance in industrial plants generally would aid materially in reducing overall costs of production in the manufacturing departments. If the engineer will consider it in that light, he will find that his efforts will be appreciated by the plant management.

The Profit Engineer Is Welcome

It is not often that we have the pleasure of welcoming a new member into the fold so we welcome with open arms the new "profit engineer" recently introduced by the Department of Commerce. One of the two duties outlined for this new member is to act as "a clearing house for all data pertaining to the particular industry, to those industries providing sources of supply and to those consuming the product."

It does not require a great deal of thought or concentration to see that for almost 35 yr. we have been profit engineers in deed if not in title. But now we know; no longer do we have to lead a Jekyll and Hyde existence. In the past, we have been classified as publishers at publishers' gatherings, as journalists at journalistic meetings and power plant engineers at engineering meetings. But no longer is it necessary to lead this double or triple life, never knowing whether we are fish or fowl. With all the sanction of a government specification we are "profit engineers" and profit engineers, we would have you know, are a vital factor in the prosperity of all industry.

Success to the N.A.P.E. Convention

On the occasion of the 48th annual convention of the National Association of Power Engineers, to be held in Cleveland during the week of September 8, we extend to the Association our congratulations on its long and useful existence up to the present and our hope that its success and influence in the engineering world may continue.

Such conventions of engineers have a value that cannot be measured merely in terms of technical papers presented and engineering information exchanged. There is a social and professional value, entirely aside from the details of the work, in meeting occasionally with a large group of fellow-workers, that gives the individual engineer a renewed sense of solidarity in a common craft and a strengthened feeling that he and his fellows are performing indispensable service to society.

It is regrettable that the layman, the man for whose ultimate benefit engineering is carried on, cannot in some way be made to absorb the spirit of a great engineering meeting such as this. This layman is altogether too quick to sneer at all conventions as mere excuses to get away from home and play golf continuously for three or four days. But as every member of the N.A.P.E. knows, that is not the sort of annual meeting it holds. The members of that organization and of all other engineering bodies we know about, meet with a high sense of their responsibility, an increasing appreciation of their function in modern industry and an incessant urge forward to keep ahead of the rapid development that is now taking place in engineering.

With such a spirit, we feel that the N.A.P.E. Convention in Cleveland should be one of its most successful and beneficial meetings leading forward to many similar ones in the future.

Correlate Instrument Selection with Plant Design

In spite of the fact that the value of reliable instruments is admitted by practically all engineers, it seems to be difficult for them to consider installation and application of instruments as anything but an afterthought, something to be added after the plant is built rather than as an important part of the plant design.

First in importance come those instruments necessary for the safety of the equipment such as the boiler pressure gage; second, those necessary for efficient operation of each unit such as CO_2 meters; third, those instruments, such as flow meters, which help to coordinate the various units and properly proportion the load; fourth, those necessary for calculating the efficiency of the plant or individual units and fifth, those which give records which can be referred to by the supervisory force.

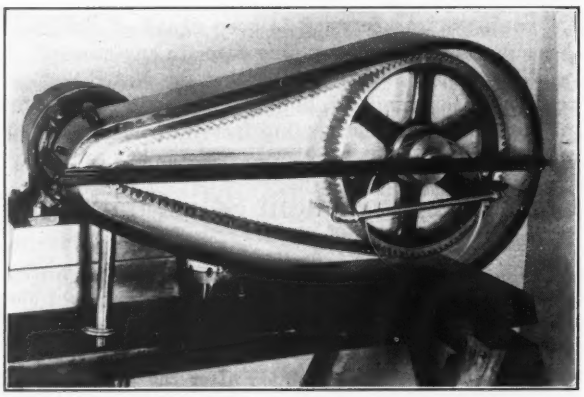
Most important, however, is that some provision be made for periodically checking or calibrating each instrument so that its readings can be relied upon. An inaccurate gage or thermometer is worse than no instrument at all because its indications are usually accepted without question by the operators and relied upon, often leading to serious and expensive accidents or high maintenance charges.

Plans for proper selection, location and calibration of instruments can be made to advantage early in the design stages and thus eliminate costly changes later on. Furthermore, instrument costs are but a small fraction of plant equipment costs. When all are purchased together on a single requisition or order with the equipment itself, approval is easily obtained, as a rule, while if they are purchased later, after the work is completed, it is often a difficult matter to get approval of the management for additional material. A few hundred dollars added to a $50,000 order doesn't look big but when separated its size is magnified.

Power Plant Engineering Developments and News

Automatic Ring Oiler

RECENT development in chain drive lubrication is an automatic ring oiler shown herewith. Running of chain drives in oil baths is not considered advisable, according to the manufacturer of this oiler, unless the



RING OILER INSTALLED IN EXHIBITION MACHINE WITH GLASS FRONT

speed is very slow, as the oil is churned into a mist which may seep out through the case and this churning also oxidizes the oil more rapidly. The oil and the mechanical parts become heated to an undesirable degree, it is stated, as the oil prevents rapid radiation of heat from the moving parts. When run in an oil bath, any dirt in the oil may be carried up with the oil and may cause unnecessary abrasion on the chain and sprockets. The ring oiler is designed so that only clean oil is carried up and into the chain.

The ring is made from rod steel and the ends sweated together. This ring travels in a groove turned in the hub of one of the sprockets. The oil is taken off this ring by a wiper. From the wiper, it is carried in a pipe to near the center of the chain, where it is dropped on the inside of the chain. The automatic ring oiler is made by Morse Chain Co., Ithaca, N. Y.

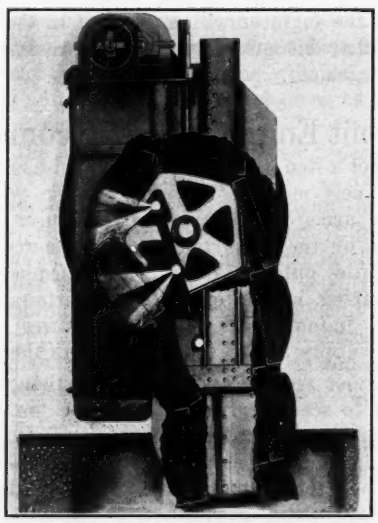
Traveling Water Screen

INCORPORATING several important improvements, the new 1930 model traveling water screen, a redesign of its former type, has just been announced by Link-Belt Co., Chicago, Ill.

Particular stress is laid on the construction of the screening trays and baskets for elevating the trash; it is stated that the tray construction is so different that each tray now has approximately 10 per cent greater depth of effective screening area. The trays are constructed with heavy-section angle iron one-piece frames, which are made extremely rigid to withstand maximum pressures encountered during flood and tide emergencies.

Other features are the overlapping of the trays the use of seal plates between the ends of the trays and the rugged elevating chains to which they are secured, to prevent the passage of trash, since the space between trays, in the guides, and in the boot, is reduced to an absolute minimum.

Chain wear does not affect the overlapping feature, it is stated, and the openings between trays are actually smaller than the openings in the screen cloth.



HEAD SECTION OF LATEST DESIGN CLEAN WATER INTAKE SCREEN WITH BACK SPRAY

The drive consists of a motor with moisture-proof windings, a herringbone-gear fully-housed speed reducer running in oil and equipped with anti-friction bearings and a suitably guarded finished-steel roller chain drive to the screen headshaft. The drive is designed to be compact and out of the way of the water spray.

Potentiometer Pyrometer

FOR MEASURING and recording temperature, an instrument has recently been developed by the Uehling Instrument Co., 30 Vesper Street, Paterson, N. J. This instrument, known as the self-contact Potentiometer Pyrometer, was primarily designed for measuring high temperatures as experienced in the iron, steel

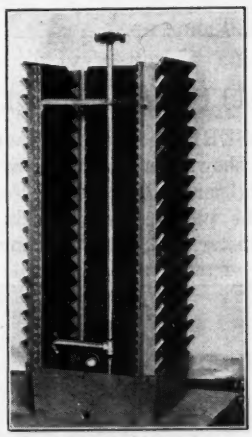
and ceramic industries. It is claimed that it lends itself equally well, however, to the measuring and recording of any temperatures where a high degree of accuracy is desired. Either a thermo-couple or an electric resistance bulb may be used as the temperature element.

A single galvanometer is designed to actuate as many as four recorders, each recorder in a different location, each measuring a different temperature and, if desired, each having an entirely different calibration.

The entire recording mechanism is fastened to a frame which is hinged to the case, to permit accessibility to all parts of the apparatus. A small motor operates only as and when necessary to adjust the pen to the proper temperature reading on a clock driven chart. It is also in geared connection with two pulleys over which a translucent endless belt, about 2 ft. long, is placed. The belt is calibrated in temperature units to move in direct proportion to the pen mechanism but at a greater speed. This, it is claimed, permits an open and legible scale which moves in back of a pointer fastened to the door. Legibility of the figures, the exceptional length of the scale, and the fact that it is illuminated from the rear, are intended to make it easily read under all conditions at a distance of 75 ft. or more.

Spray Cooling Tower for 12 G. P. M.

TYPE G Marley spray tower recently placed on the market is designed to be a compact durable cooling unit for use where only a few gallons capacity is needed. Its maximum capacity is 12 g.p.m. It is 7 ft. high, 3 ft.



INTERIOR VIEW OF TYPE G SPRAY COOLING TOWER

wide and when full of water weighs 860 lb., with water storage of 38 gal.

Water box, main tower frame-work and bracing are of cast iron.

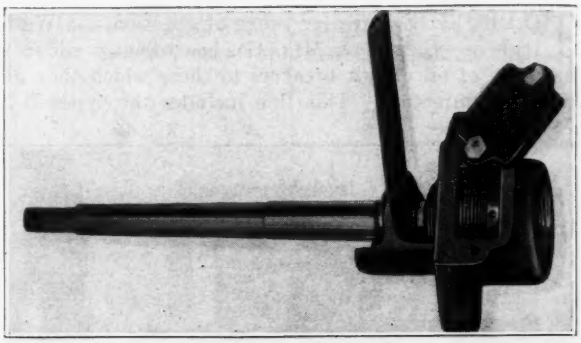
Entire main frame-work is designed for assembly in a few minutes. Louvres of California redwood are designed for slip fit, to eliminate nails or screws. The automatic float valve is standard equipment.

Marley spray nozzles, designed to give fine water breakup and to be non-clogging, are used, the size and number depending on the capacity desired. This tower is a recent product of the Marley Co., Kansas City, Mo.

Type Q Centrifugal Pump

TYPE Q CENTRIFUGAL PUMP recently placed on the market is designed as a single-stage, single suction pump for operation at heads up to 300 ft. maximum handling small volumes of liquid. It is built in capacities from 5 to 35 g.p.m. for direct connection to standard speed motors.

Of especial interest in this new pump is the design of the impeller shown in the accompanying illustration.



TYPE Q PUMP IMPELLER WITH SUCTION STUFFING-BOX

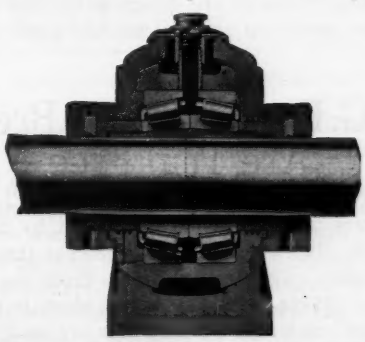
This consists of a hub, suction eye and one hollow vane of stream line section with knife edges. The vane is a stamping welded to the hub; the hub and suction eye are a casting. The entire impeller is of stainless steel.

Suction eye of the impeller is sealed against loss of pressure by the suction stuffing box which is designed so the packing can be adjusted without disturbing piping or pump. Inboard head stuffing box of split bolted gland type with drain, water slinger on shaft, deep groove ball bearings in sealed housing with compression grease cup, flexible coupling and drip pan type base are other features. The pump is a new product of American Steam Pump Co., Battle Creek, Mich.

Ball and Socket Pillow Block

TIMKEN anti-friction ball and socket pillow block, just announced by Link-Belt Co., Chicago, Ill., was designed several years ago, has been improved and perfected in the meantime and has been actually service-proved in practically every type of service, according to its manufacturer.

These pillow blocks are designed to fit any good grade of commercial shafting, from $1\frac{7}{16}$ in. diameter to



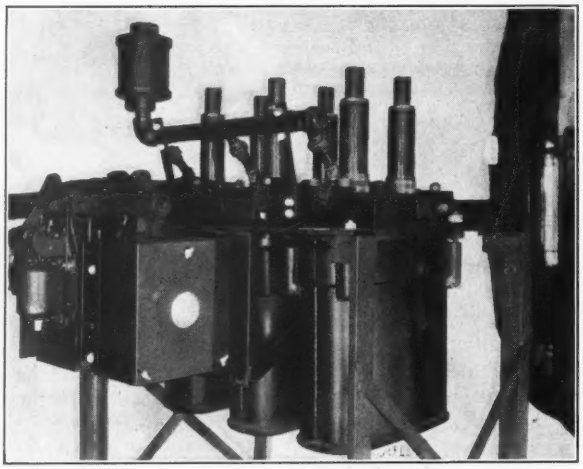
CROSS-SECTION OF NEW BALL AND SOCKET PILLOW BLOCK

the largest size, without special fittings or the use of appliances.

These pillow blocks use pressure lubrication. The grease is forced in at the center and out at the shaft openings. Thus, with the addition of the grease seal at the top, dust and grit are kept out of the bearing, it is stated.

Westinghouse Adds to Circuit Breaker Line

TO PROVIDE a greater range of selection, the Westinghouse Electric & Mfg. Co. has recently added a new line of oil circuit breakers to those which they already manufacture. This line includes the types B-7,



ASSEMBLY OF TYPE B-8 OIL CIRCUIT BREAKER

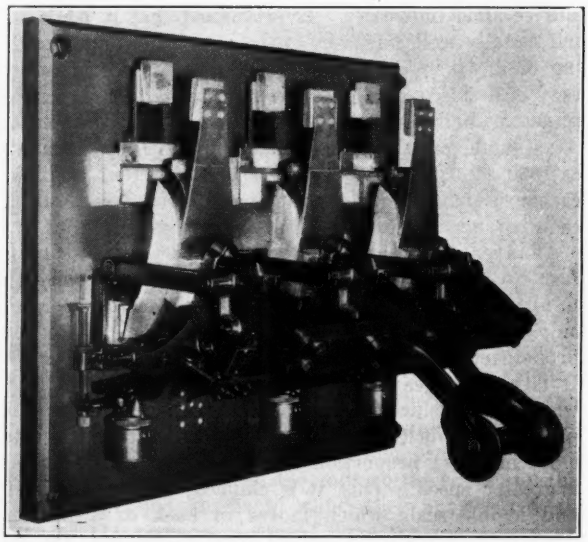
B-8, B-9 and B-10 breakers which are rated at 15,000 v. and 400 to 2000 amp.

Types B-7, B-8, B-9 and B-10 oil circuit breakers comprise a line of compact breakers of medium interrupting capacity ratings at low voltages. They have been designed for indoor service only and especially for use in power plants and substations where a small space is available for switching equipment.

These breakers are manually or electrically operated, and are available with one, three or four poles, single-throw. They are essentially for remote control form only, which is in accordance with the A. I. E. E. recommendation that circuit breakers for use on circuits of more than 2500 v. be mounted away from the switchboard. These breakers are designed for truck or structural frame mounting and are readily applicable to cell mounting.

New G.E. Air Circuit Breakers Are Trip Free

RECENTLY, A NEW line of "trip-free" air circuit breakers was placed on the market by the General Electric Co. The advantages claimed for these breakers are as follows: They are trip free from the handle on overcurrent; there is triple contact; there is no burning on the main brush; the burning tips are easily replaced; the high-pressure main contact is formed of laminations which make "end-on" contact with heavy and uniform



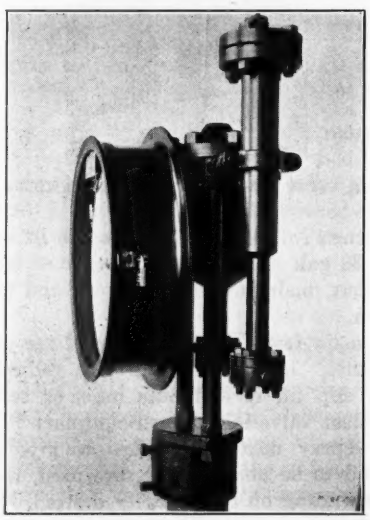
TYPE CK-8, 480-V., 3000-AMP. BREAKER

pressure, and yet is closed easily with a wiping motion and they have low operating temperature. The breakers are available for either instantaneous or time delay automatic operation in either single-, double, or triple-pole combinations with necessary accessories.

There are three classifications of breakers for voltages of 650 volts and below: the type CN-1 is a compact breaker applicable to industrial service and for circuits in buildings where the current is from 3 to 300 amp. The type CP-108 is a breaker for moderate duty service rated 1200 amp. and below. The type CK-8 is a heavy-current breaker for moderate or heavy-duty service ranging from 1600 amp. up.

Flow Instruments for 2500 lb.

HIGH-PRESSURE recording flow meter and flow controller, shown here, is built for operating pressures of 2500 lb. per sq. in. by the Foxboro Co., Foxboro, Mass. The picture shows a single-pen 2500-lb. recording flow meter. If static readings are needed, a



SINGLE-PEN RECORDING FLOW METER FOR 2500 LB.

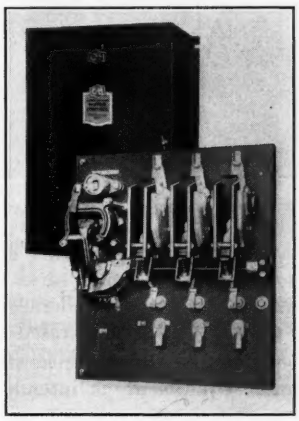
two-pen instrument with static element is furnished. When total flow readings are desired, an integrator can be supplied on the instrument. The integrator, a Foxboro product, is designed to give the flow readings without the use of any multipliers.

The meters and flow controllers can be mounted in place without the use of loading devices.

All parts of the new instruments are specifically designed for high-pressure applications. All working parts are drop forgings.

Two New Heavy-Duty A. C. Contactors

TWO NEW MAGNETIC contactors, for heavy-duty a.c. service, are announced by Cutler-Hammer, Inc., 191 12th St., Milwaukee, Wis. They are rated for maximum capacities of 300 and 600 amp. respectively.



300 AMP. HEAVY DUTY A.C. CONTACTOR

Features of these new contactors make them generally applicable to all heavy-duty requirements. They are arranged for either two or three-wire control, have continuous-duty operating coils, highly efficient magnet structure and exceptionally heavy, butt type, solid copper contacts. An air cushion absorbs the shock of the magnet on closing, thus reducing wear and making the contactor operate more quietly. For general use, the 300-amp. contactor is mounted in a wall type enclosure, and the 600-amp. size is in a floor type case.

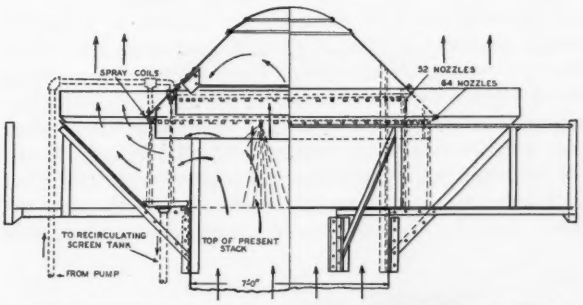
Smoke and Soot Washer

DESIGNED to remove fly-ash, fine cinders, soot and other dirt from flue gas issuing from chimneys, the smoke and soot washer shown here has recently been placed on the market by The American Smoke & Soot Washer Co., Inc., New York.

This washer consists essentially of two cones, one cone A directly on top of the existing stack, the other B, with a rounded top supported above the top of the stack. Two water spray rings inside the top cone near its lower edge are provided with flat spray nozzles to produce a double annular curtain of water completely surrounding the top of the stack.

Path of the gases through the washer is shown by the arrows. The water curtain is designed to throw down the particles of fly-ash and soot and remove sulphurous fumes. Circular baffles are used inside the spray coils to prevent short-circuiting of the gas.

Drain C leads to a tank provided with screens and baffles to catch the solid matter and a centrifugal pump is provided to recirculate the water from this tank to the nozzles, a pressure of 20 to 30 lb. being maintained at the nozzles.



CROSS-SECTION THROUGH SMOKE AND SOOT WASHER

Copper spray rings and tobin bronze nozzles are used and corrosion resisting metal covered by protective paint forms the body. With slight modifications, the washer is equally adapted, it is stated, to either brick, concrete or steel stacks.

Hydrovac Dust-Handling System

FOR REMOVAL of fly ash, dust, soot or siftings from hoppers where they have been collected, the Hydrovac dust handling system has recently been placed on the market by Allen-Sherman-Hoff Co., Philadelphia,

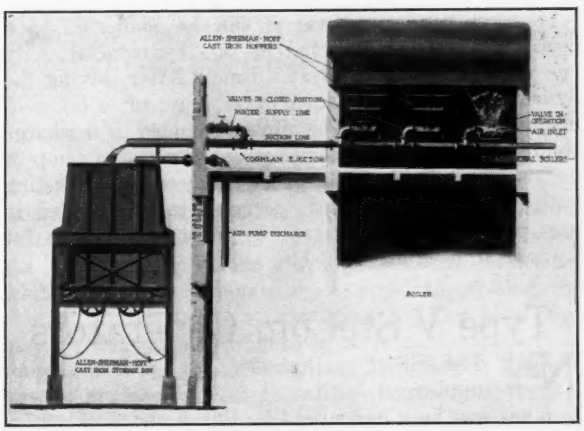


FIG. 1. APPLICATION OF THE HYDROVAC SYSTEM

Pa. The system is totally enclosed and designed to be dust-tight and water-tight to assure cleanliness in removal and disposal of the dust. It is designed to remove the dust in a dry condition through an A-S-H wind-swept valve and to mix the dust thorough with water and discharge it by a Coghlan type Hydrovactor, Fig. 3.

The wind-swept valve, Fig. 2, is bolted to the bottom of the dust collection hopper as shown and is arranged so that dust piles in the body of the valve. On each side of the valve are ports, one connected to the suction line

leading to the Hydrovactor, the other to serve as an air inlet. When the valve is not in operation, both ports are sealed by a rotary valve, which extends through the body, to prevent infiltration of air through the unit to the dust hopper. When dust is to be removed, the rotary valve unit is turned 90 deg. by an operating lever at the air inlet end of the valve. The valve has hollow ends and, when rotated, openings in the side of the cylinder coincide with the inlet and discharge ports.

The Coghlan type Hydrovactor consists of a ring of water nozzles fed from a circular header so that high-velocity water streams from these nozzles converge in the Hydrovactor. This action is intended to entrain the dust-laden air and to produce a vacuum in the suction line between the wind-swept valve and the hydrovactor so that air will enter the open port, will be pulled through the pile of dust in the valve and will carry the dust particles through the discharge port and suction

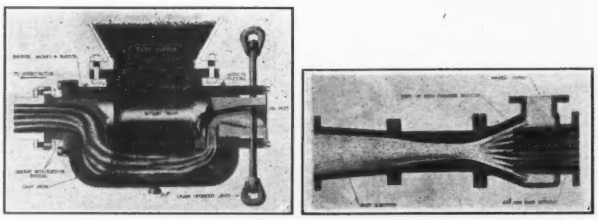


FIG. 2. LEFT—WIND-SWEPT DUST VALVE
FIG. 3. RIGHT—COGHLAN TYPE HYDROVACTOR

line to the hydrovactor. Here the water mixes with the dust particles and the mixture passes through a discharge line to disposal. Since the vacuum produced in the wind-swept valve is in direct proportion to the quantity and velocity of the water in the hydrovactor, it is claimed that it is impossible to overload or dam the system.

Several wind-swept valves can be connected to a common suction line served by one hydrovactor, only one valve being operated at a time. After leaving the hydrovactor, the dust laden water is piped to point of disposal, which may be the clinker chamber or discharge conduit of a Hydrojet system of ash removal, a sump or an overhead storage bin fitted with water collecting gates. The hydrovactor is designed to be installed in any position and to elevate the dust-laden water for disposal into an overhead bin.

Type V SteCom Generators

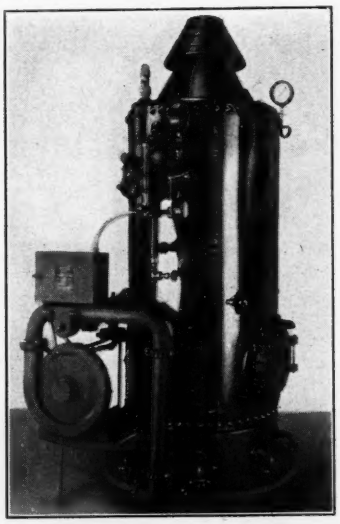
NEW SERIES of small gas-fired high-pressure boilers to supplement its line of type V SteCom generators has just been announced by Steam and Combustion Co., Chicago. Four additional sizes are provided by this step, 10, 13, 17½ and 23 hp., making a total of 10 type V boiler sizes, with a capacity range from 13½ to 10 hp.

SteCom type V boilers are complete steam generating plants, consisting of a vertical fire tube boiler shell, furnace and burner system, and controls. The boiler shell is of SteCom design, built especially for the forced draft gas combustion system with which it is combined. The type is vertical fire tube.

The SteCom combustion system, known as the Cyclone gas burner, is of the forced draft type designed to function as a unit with the boiler proper.

Cyclonic action imparted to the burning gases in the firebox by the tangential arrangement of the burners is intended to be a further aid to rapid and complete combustion.

All combustion air used in the Cyclone burner system is supplied by a motor-driven blower.



NEW TYPE V STECOM GENERATOR

The automatic turn down, a feature of the larger V type boilers, is omitted in the small series in the interest of simplicity and because most boilers of this size are operated more generally at or near rated capacity.

Operation of SteCom type V generators, assuming suitable feedwater equipment, is intended to be fully automatic.

Boulder Canyon Power Plant

RECENT REPORTS on the Boulder Canyon development on the Colorado River show that plans for the power plant to be built there are still in a preliminary stage. Number and rating of turbines, generators and other equipment will not be definitely decided until the river

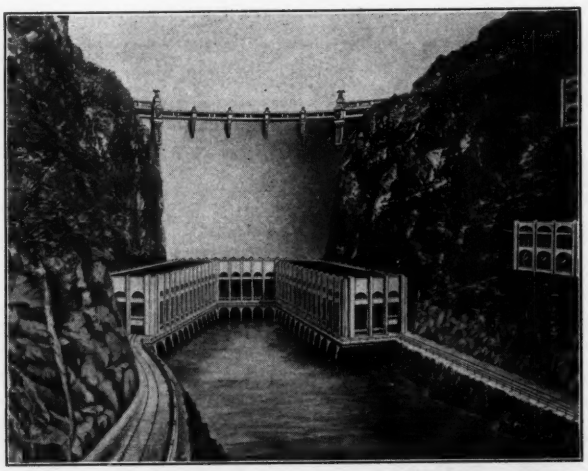


FIG. 1. BOULDER CANYON POWER PLANT AND DAM ON COLORADO RIVER AS IT IS EXPECTED TO APPEAR WHEN COMPLETED

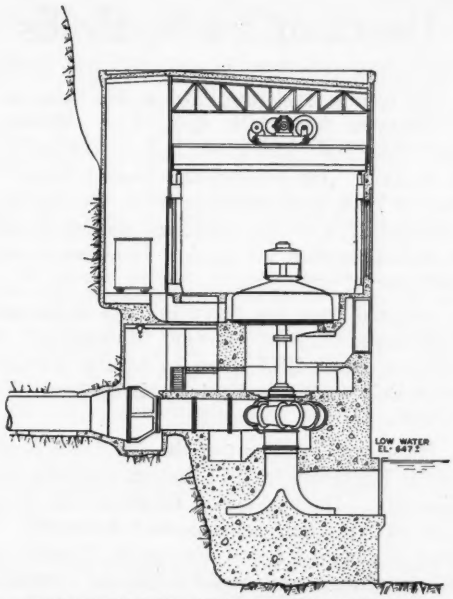


FIG. 2. CROSS-SECTION THROUGH PROPOSED BOULDER CANYON POWER PLANT

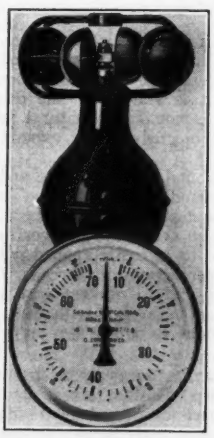
has been diverted around the dam site through the diversion tunnels.

The power plant will probably contain at least 12 generating units, the turbines rated at 85,000 hp. and the generators at 75,000 kv-a.

Figure 1 shows the proposed power plant and dam drawn on a photograph of the dam site. Figure 2 shows a cross-section through the proposed power plant.

Air Velocity Meter

O-Z ANEMO TACHOMETER or air velocity meter, recently developed, is designed for measuring air velocity in tubes, air ducts, compressed air pipes and in



TACHOMETER FOR MEASURING AIR VELOCITY

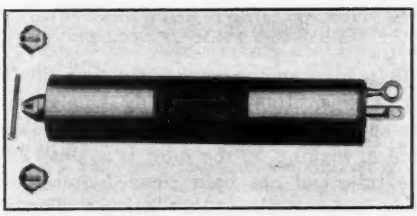
all places where a knowledge of the speed is needed for testing purposes, as well as in the open air.

The instrument is a combination of the Robinson cup cross and centrifugal tachometer. The cup cross, on the extension of the pendulum shaft, receives a definite average angle velocity when exposed to an air current. The result is transmitted to the hand of the instrument reading over a scale graduated from 10 to 70 mi. per hr. and 5 to 35 meters per second. All parts of the instrument are enclosed in a strong aluminum housing and the cups have a wire guard. With the handle, the instrument weighs 2 lb. It is a product of O. Zernickow Co., 15 Park Row, New York.

Liquid Sampler

HILLS-McCANNA liquid sampler is designed as a means for obtaining an accurate, composite sample of practically any fluid, quickly and easily. Samples from three levels of tanks or tank cars are obtained in a single operation. Even the extreme bottom of the vessel is reached.

The sampler is designed to operate on the single plunger suction principle. It consists of a hollow metal cylinder, 13½ in. long, made of non-sparking metal. A close fitting piston without packing operates on the inner wall of the cylinder. Interchangeable nozzles for



LIQUID SAMPLER HAS NOZZLES FOR LIQUIDS OF DIFFERENT VISCOSITIES

handling liquids of varied viscosity are provided for the outlet in the lower end of the cylinder.

Further details concerning the sampler may be obtained from the Hills-McCanna Co., 2349 Nelson St., Chicago, Ill.

Pipe Threading Machine

NEW PIPE THREADING MACHINE, designed for a wide range of uses, has been developed by the Axelson Manufacturing Co., Ltd., Los Angeles, Cal. In operation the pipe that is to be threaded remains stationary while the standard square die is revolved, cutting the thread. Long stands of assembled pipe or bent pipe may be conveniently threaded, it is claimed, as it is unnecessary to rotate the units. The work is gripped by two jaw chucks designed to be practically automatic and instantaneous in action. Standard square dies, obtainable from practically any supply house, are readily adapted to the cutter thread. Threads can be cut on material from ½ to 2 in. in diameter and the power is supplied from a ½-hp. compound-wound motor, installed directly beneath the pipe holder brackets. Electric current of 110 or 120 v., either 50 or 60 cycle, may be applied.

The manufacturer claims that the threader will cut at the rate of 17 r.p.m. on all sizes from ½ to 2 in. and that the required time for completing 11 threads is about 40 sec. After the thread is completed, the dies are reversed and during this operation rotate at 34 r.p.m.

Streamline Fittings for Piping Systems

STREAMLINE FITTINGS for copper piping have recently been placed on the market. They are designed to eliminate pipe threads and flares; the joints are designed to be made by means of the blow torch, solder and utilization of the law of capillary attraction so that hard drawn, thin-walled copper tubing can be used.

Herewith is a sectional view of a joint between streamline copper water tube and a streamline tee. It is

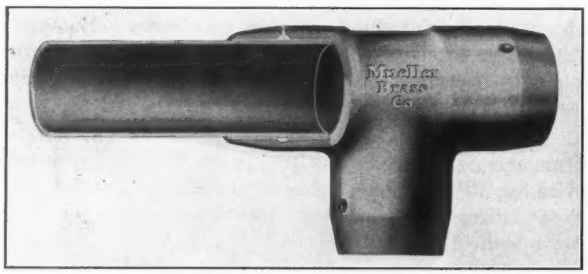


FIG. 1. SECTION OF JOINT BETWEEN TUBE AND TEE SHOWING FILM OF SOLDER

claimed that microphotographs show that this thin film of solder between tube and fitting amalgamates with both tube and fitting to form practically a solid joint.

Method of making up the joint is as described below. After the tube end has been cleaned and solder paste applied, it is inserted in the fitting. The fitting is heated uniformly with a blow torch and wire solder is fed through a conveniently drilled hole into the solder channel until it appears at the tapered end of the fitting. The law of capillary attraction is claimed to be the basic principle underlying this action.

Advantages claimed for these fittings are: reduction in weight and space, installation close to walls and ceilings, and in places otherwise inaccessible, neat appearance, minimum pressure drop in the piping system.

In addition to the regular elbows, tees and couplings, special fittings are available with one outlet threaded so that a job using this material can be tied into an existing iron pipe installation. These fittings are a product of the Mueller Brass Co., Port Huron, Mich.

PRODUCTION OF ELECTRICITY by the electric light and power industry of the United States for the week ended Saturday, August 16, was 1,671,393,000 kw-hr., according to the Statistical Research Department of the National Electric Light Association. This is about 8,000,000 kw-hr. less than the output of the previous week. It is 2.8 per cent below the figure for the corresponding week in 1929 but 9 per cent above the output for 1928. During the first six months of this year, 68,532 additional farms were electrified, the Statistical Research Department states. This compares with a figure of about 48,000 for the first six months of 1928. On June 30, the electric light and power industry served a total of 627,105 farms as compared with a total of 558,573 on the first of January, an increase of more than 12 per cent.

GENERALLY, one operator and one helper can handle about 10 stoker fired boilers.

Death of Ira N. Hollis

IRA NELSON HOLLIS, former president of Worcester Polytechnic Institute, died at his home in Cambridge, Mass., on August 15, aged 74 yr. He was born in Mooresville, Ind., and graduated at Louisville High School in 1872. He entered the United States Naval Academy in 1874, graduating in 1878. During the next 15 yr. he served in various positions concerned with the design and operation of marine machinery and was chief engineer of two ships.

He resigned from the Navy in 1893 to become professor of engineering at Harvard University. He remained there until 1913 when he became president of Worcester Polytechnic Institute, retiring from this position in 1925.

Dr. Hollis was president of the American Society of Mechanical Engineers in 1917 and an honorary member of the society. He was also a fellow of the American Academy of Arts and Sciences and a member of the American Society of Naval Engineers, Boston Society of Civil Engineers and Society for the Promotion of Engineering Education.

News Notes

THE BOILER ENGINEERING CO., of Newark, N. J., announces its affiliation with the Plibrico Jointless Firebrick Co. of Chicago. Products of the Boiler Engineering Co. will now be marketed through the Plibrico representatives in the United States and Canada and refractory material used in the construction of its baffles will be formulated from its Plibrico clays. The Boiler Engineering Co. will continue to maintain headquarters at Newark. Correspondence should be addressed to the Newark office or to the various local Plibrico representatives. The main offices of the Plibrico Jointless Firebrick Co. will remain at Chicago.

ST. JOHN X-RAY SERVICE CORP., 505 Fifth Ave., New York, has installed what is said to be the first X-Ray plant of its kind at the Barberton, Ohio, works of The Babcock & Wilcox Co. The photographic apparatus will be used primarily for routine inspection of welded seams in pressure vessels, heat exchangers and similar equipment. Dr. A. St. John is president and technical director of the company.

MANUFACTURE of a new plastic, expansive compound for sealing joints, called Q-Seal, has just been announced by Quigley Co., Inc., 56 West 45th St., New York City. Compounding of this material was made possible, it is stated, by the discovery of a mineral, which, it is claimed, is not only a natural lubricant and preserver of metal but when subjected to heat expands to several times its normal volume.

This mineral is ground extremely fine and used as the principal pigment in the compounding of Q-Seal. The principal vehicle or mixing agent used is designed to be impervious to crude oils, all of their derivatives and acids, and non-corrosive.

Q-Seal is intended to be easily applied with a brush to joints to be sealed to fill imperfections in threads, flanges or gaskets, to seal joints leakproof and to prevent rust and corrosion. Joints fabricated with it may be broken with ease, it is claimed, regardless of age or conditions to which they have been subjected.

NORWOOD A. MILLER, formerly assistant engineer at W. F. Schrafft & Sons Corp., Boston, Mass., has been appointed chief engineer to fill the vacancy caused by the death of Chas. F. Hill.

MURRAY IRON WORKS CO., Burlington, Iowa, announces the following appointments of selling agencies for its products: Wm. Stairs, Son & Morrow, Ltd., Halifax, Nova Scotia, Canada; Mathews & Co., 734 Brookhaven Drive, Orlando, Florida.

CLIMAX ENGINE SERVICE CO., 115 Broad St., New York, has just been appointed service repair parts business representative of the Climax Engineering Co. of Clinton, Iowa, and Chicago. This representative succeeds John H. Reiner Co. It will handle repair parts for all the organization's products.

Books and Catalogs

FORMATION AND PROPERTIES OF BOILER SCALE. By Everett P. Partridge. Published by the Department of Engineering Research of the University of Michigan, Ann Arbor, Mich., as Engineering Research Bulletin No. 15; 170 pages; paper bound, 6 by 9 in.

Complete summary of information concerning boiler water treatment arranged in four parts and four appendices, each unit complete in itself. Part I summarizes the data on thermal effects of boiler scale as an argument for the necessity of scale prevention; Part II defines the chemical constituents of boiler scale, the crystallographic properties of these constituents and their solubility in water over a range of boiler temperature; Part III discusses the process of scale formation in the light of recent experiments and current theories and Part IV deals with methods of scale prevention.

Not the least important is a separate bibliography prepared for each of the four parts of the bulletin. This was written not directly from a standpoint of scale prevention but rather for presenting what is known about scale formation in order that problems involved in its prevention might be attacked in the most rational manner.

PROCEEDINGS of the Midwest Bituminous Coal Conference held at Purdue University April 9-11, 1930, have just been issued as Extension Series Bulletin No. 22 by Engineering Extension Department, Purdue University, Lafayette, Ind.

TWO NEW PUBLICATIONS pertaining to mechanical power transmission equipment for general industrial use have been issued by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Westinghouse-Nuttall Flexible Couplings is the subject of Circular 1887, which contains complete descriptions, capacities, dimensions and weights of the different types. Illustrations include typical applications of each type. Circular 1891, entitled Westinghouse-Nuttall Speed Reducers Types SVR, DVR and DVRA, contains full information about the application, construction, ratings and dimensions of these vertical type units for single and double reductions and right-angle drives. Numerous existing applications of the different types are illustrated.

THE FIRST ISSUE of "Borsig Technical Review" dealing with modern power equipment used abroad is now off the press and a number of copies of the first issue are available upon request to the Seamless Steel Corporation, 39 Broadway, N. Y.

RESUME OF a line of centrifugal pumps specially adapted to sewage disposal and water supply for municipalities, entitled Chicago Pumps for Municipalities—No. 16, has been published by Chicago Pump Co., 2336 Wolfram St., Chicago, Ill.

It shows vertical pumps of the non-clogging type in both open and closed shafts, typical layouts, installations, horizontal pumps of single and multistage for water supply, gas engine driven pumps for auxiliary use and bilge pumps for drainage.

NEW BULLETIN describing waste heat boilers of an entirely different character from those used in the past has just been issued by the Foster Wheeler Corp., 165 Broadway, New York City.

The boilers consist of heating elements of seamless steel tubes covered with cast iron extended surface, reamed to size and shrunk on the heating tubes.

Several of the boilers have been in operation for more than a year. The first installations were made in connection with the exhaust gases from Diesel engines. The boilers are designed to be run as flash boilers, the steam production being controlled by setting the feed valve for the desired steam quantity. The catalog shows several designs, installations and details of construction of interest to those having waste gases at temperatures above 500 degrees. The bulletin is known as WB-30-2.

BELT CONVEYORS are discussed in a 176-page data book, No. 1615, flexible covered, prepared to facilitate the selection and application of the proper type of belt conveyor for handling any material in quantities desired. The following subjects are discussed: Belt conveyor drives, stresses, care, lubrication and maintenance of belt conveyor idlers, diagrams of typical belt conveyors, dimensions, prices and data concerning various types of idlers and driving mediums, engineering charts, data and suggestions, feeders and their selection, general data on motors, illustrations of typical installations, selecting the idler, tables showing proper selection of a belt conveyor for handling a given material at a desired speed, typical belt conveyor designs and selection, various types of trippers, anti-friction idlers. The book is published by Link-Belt Co., 300 W. Pershing Road, Chicago, Ill.

IN A NEW loose-leaf binder are contained all the bulletins on the Whiting stoker, including some new material just issued. These bulletins show details of the stoker, present a series of six articles on firing of small boilers by Joseph Harrington. Many data on installations are given. The binder is issued by Joseph Harrington Co., subsidiary Whiting Corp., Harvey, Ill.

FINISHING, MAINTAINING, Weather-proofing and decorating concrete, brick and stucco with Tnemec Coatings are discussed in a new bulletin by Tnemec Paint & Oil Co., 3122 Roanoke Road, Kansas City, Mo.

NEW WF-1 INSTRUMENT CURRENT TRANSFORMER is described in Bulletin GEA-1269 by General Electric Co., Schenectady, N. Y. Centrifugal compressors, details of their construction and typical installations are discussed in GEA-1280. In GEA-1161, many interesting data are given on Arc Welding Structural Steel. Details of joints, erection methods, design of welds and of steel work for welding and qualifications of welders are among the subjects treated. Copper Brazing and Copper Brazing Furnaces are described in GEA-1291. The following leaflets and circulars have also been issued recently. GEA-211A, Type FK-5 Oil Circuit Breakers, for manual or automatic operation 300, 500 and 800 amp. 600 v., 300 and 500 amp., 7500 v.; GEA-1290, and GEA-388A, Type MT Control Equipment for direct-current motors for steel-mill auxiliaries and cranes; GE-885A, Super synchronous motors, 100 to 4000 hp.; GEA-858A, Low-speed direct-current generators; GEA-750B Induction frequency converters for furnishing power to high-speed motors at higher than normal frequencies; GEA-1295 Edgewise-wound resistors; GEA-1265A, thermostat for use with industrial heating units; GEA-1285, Track-type limit switches for control circuits; GEA-904D, single-stage centrifugal air compressors for cupola blowing; GEA-977B, fractional horsepower capacitor motors; GEA-1096A, Indoor disconnecting switches; GEA-1296, brakes for direct-current motors.

YOUNGSTOWN PIPE is completely described in a new 72-page book by Youngstown Sheet & Tube Co., Youngstown, Ohio. Tables of dimensions, weights and other necessary data are given for all types of pipe and tubes, both welded and seamless. Interesting short descriptions are given of the manufacture of both welded and seamless pipe and suggestions for care of oil country pipe. The company has also issued a Standard Pipe Reference Book, an 86-page book primarily intended to aid in laying oil piping. Following tables of pipe data and engineering data, information is given on laying out various types of bends and joints using fittings. Contents of pipes, water supply, sprinklers, tanks, heating and related subjects are treated.

GAS UNIT HEATERS are described in Bulletin No. 2754 by Buffalo Forge Co., Buffalo, N. Y.

AFTERCOOLERS for cooling and drying air after it has been compressed and before it is delivered to service pipes are described in Bulletin No. 150 just issued by Pennsylvania Pump & Compressor Co., Easton, Pa.

FIVE YEARS of Research in Industry, 1926-1930 is a reading list of articles on research in various fields published by various magazines and societies. It is published by National Research Council, Division of Engineering and Industrial Research, 29 West 39th St., New York.

MULTI-V-DRIVE for power transmission is described in Bulletin L-900 by Worthington Pump & Machinery Corp. Construction of the Goodyear belts employed, of the sheaves, and details of installation, are treated.

IN ITS NEW CATALOG No. 88, Walworth Co., Statler Bldg., Boston, Mass., has compiled a most complete and attractively arranged catalog of 754 pages, covering in detail its complete line of valves, fittings and tools. This book is bound in red cloth, is well illustrated with views of each item and phantom photographs where needed to show construction, the typography is excellent and the entire book is designed for the convenience of the user. One of its features is a thumb index at the center of the book, a two-page spread giving page numbers and arrows pointing to the beginning of each subdivision for quick reference. The catalog begins with bronze valves and fittings, to give prominence to a distinctive product. On all valves recommended for oil water and gas service, the ratings are given. Throughout the book text matter gives the salient points of the more important items. At the beginning of the steel section a recommendation chart for steel valves and fittings is given, covering pressures, temperatures and trim materials for various classes of service. The book is replete with data tables, dimension tables and diagrams, price lists and all necessary data. Subjects treated are: bronze valves and fittings, bronze, iron body and all-iron cocks, Kewanee Union specialties, iron body valves, fire protection, valves and fittings, Sigma steel valves and fittings for pressure up to 3500 lb. at 100 deg. and 1200 lb. at 1000 deg., forged steel products, fabricated piping, brass, malleable iron and cast iron fittings, C.N.I. cast pipe and fittings, pipe tools and miscellaneous products.

Power Plant Construction News

Ark., Malvern—The Southern Ice & Utilities Co., Second Street, Little Rock, is said to be planning the construction of an ice-manufacturing plant on Main Street, Malvern, where site has been acquired, estimated to cost about $45,000.

Ark., Siloam Springs—J. W. Sloan, Tulsa, Okla., is at the head of a project to construct and operate a hydroelectric generating plant in the vicinity of Siloam Springs, reported to cost about $200,000. Victor Cochrane, Tulsa, is engineer.

Calif., Fruitvale—The Oliver United Filters Co., Fourth and Madison Streets, Oakland, plan installation of electric power equipment in proposed new filter equipment manufacturing plant at Fruitvale to cost over $400,000, for which plans are being completed by Reed & Corlett, Oakland Bank & Savings Building, Oakland, architects.

Colo., Lake City—R. D. Webb, Lake City, and associates are considering the construction of a hydroelectric power plant on the Gunnison River, vicinity of Lake San Cristobal, entire project reported to cost over $400,000. Application for permission has been made to the Federal Power Commission.

Conn., New Haven—The Connecticut Drug & Perfume Co., 108 State Street, plans installation of electric power equipment in proposed new four-story factory addition to cost over $100,000. Jacob Weinstein, New Haven, is architect.

Conn., New Haven—The Howard Co., New Haven, is said to be planning the installation of electric power equipment in connection with its proposed rebuilding of brick manufacturing plant, recently destroyed by fire with entire loss reported in excess of $100,000.

Conn., New London—The Board of Trustees, Connecticut College for Women, has filed plans for a one-story boiler plant at the institution, 45 x 68 ft., reported to cost about $40,000, with equipment.

D. C., Washington—The Bureau of Supplies and Accounts, Navy Department, Washington, is asking bids until Sept. 9, for two boiler feed pumps for the Great Lakes navy yard, as per Schedule 4003.

D. C., Washington—The Bureau of Yards and Docks, Navy Department, Washington, is asking bids (no closing date stated) for three 500 kw. turbo generator units to be used at the naval air stations at Pensacola, Fla., Great Lakes, Ill., and Portsmouth, N. H., respectively, as per Specification 6186.

Fla., Fort Myers—The Common Council is said to be considering the installation of a municipal electric light and power plant, for which estimates of cost will soon be made.

Ga., Lincolnton—The Common Council is said to be planning the installation of pumping machinery, in connection with a municipal water system. Estimates of cost will be made at an early date.

Idaho, Nampa—The Pacific Fruit Express Co., San Francisco, Calif., a subsidiary of the Southern Pacific Co., plans the consruction of an addition to boiler plant at precooling works at Nampa, in connection with a general expansion and betterment program, reported to cost over $50,000.

Ind., Gary—The National Tube Co., Pittsburgh, Pa., will install electric power equipment in proposed new seamless tube mill at Gary, entire project reported to cost over $1,500,000.

Ind., Muncie—The Central Indiana Gas Co., is arranging an appropriation of about $1,000,000, the fund to be used for extensions and improvements, including installation of additional gas production equipment, storage and distributing facilities, etc.

Ind., Richmond—The City Council is reported considering extensions and improvements in municipal electric light and power plant on South Eighth Street, including installation of electric generating and auxiliary equipment. John Graham is chief engineer.

Iowa, Cedar Falls—The City Council is considering the installation of a municipal ice-manufacturing plant and will secure estimates of cost at an early date. A municipal gas plant is also under advisement. Clark Streeter is city engineer.

Mass., Cambridge—The Cambridge Industrial Trust Co., has filed plans for the construction of a one-story power house, reported to cost about $40,000, with equipment. Walter A. Hall, 80 Boyleston Street, Boston, is engineer.

Mass., Holyoke—The Holyoke Water Power Co., is reported planning the construction of a new hydroelectric power plant in vicinity of South Hadley Falls, to cost over $200,000.

Mich., Detroit—The Public Lighting Commission, Detroit, has plans nearing completion for a new power substation on Mount Elliott Avenue. A similar station will be constructed at Mack and Philip Avenues, entire expansion to cost over $150,000. Smith, Hinchman & Grylls, Marquette Building, are engineers.

Mo., Hornersville—The City Council is said to be planning the installation of electric-operated pumping machinery, in connection with a new municipal waterworks, for which plans are being drawn by Russell & Axon, 6200 Easton Avenue, St. Louis, Mo., consulting engineers. Project is reported to cost about $25,000.

Mo., Lamar—The City Council is said to be planning an early call for bids for a filtration plant for the municipal waterworks. The city engineer is in charge.

Mo., North Kansas City—The Corn Products Refining Co., 17 Battery Place, New York, plans installation of electric power equipment in connection with an expansion and improvement program at mill at North Kansas City, entire project reported to cost more than $1,000,000.

Neb., Omaha—The State Board of Control, Omaha, will soon begin the construction of a one-story power plant at the local home for the deaf, for which plans have been completed by Lawrie & Stockham, Paxton Building, Omaha, architects.

N. H., Berlin—The Brown Co., Inc., is said to be planning the installation of electric power equipment in connection with proposed rebuilding of portion of pulp mill, recently destroyed by fire with loss reported in excess of $300,000.

N. Y., Syracuse—The Syracuse Lighting Co., a subsidiary of the Niagara Hudson Power Corporation, Buffalo, N. Y., has acquired property on the Hiawatha Boulevard, and plans a new artificial gas-manufacturing plant, reported to cost more than $1,000,000, with equipment.

Ohio, Canton—The City Council is said to be planning the installation of pumping machinery and auxiliary equipment, in connection with an expansion program for the municipal water system, entire project reported to cost close to $500,000. Bonds are proposed in that amount.

Pa., Pittsburgh—The Duquesne Light Co., 435 Sixth Avenue, is planning the construction of a transmission line across the Ohio River, at Vanport. Application for permission has been made.

S. C., Charleston—Your Ice Co., 104 Spring Street, John D. Howe, president, is reported planning the construction of a one-story ice-manufacturing plant to cost over $35,000, with equipment.

S. D., Mitchell—The General Manganese Co., Mitchell, recently organized, will install electric power equipment in new reduction mill at local manganese properties for which work will be placed under way at once, entire project to cost more than $200,000.

Tenn., Chattanooga—The Union Carbide & Carbon Corporation, 30 East Forty-second Street, New York, plans installation of electric power equipment in proposed new commercial oxygen and acetylene gas-manufacturing plant at Chattanooga, where tract of land has recently been secured, entire project to cost over $400,000.

Texas, McAllen—The City Commission is considering the installation of a municipal electric light and power plant, for which estimates of cost will be secured at an early date.

Wash., Seattle—The Board of Public Works will soon begin work on an addition to its power substation on Ninth Avenue, N. E., reported to cost over $60,000, with equipment.

Wyo., Casper—The Standard Oil Company of Indiana, Inc., 910 South Michigan Avenue, Chicago, Ill., plans installation of electric power equipment in proposed new refining plant at Casper, entire project reported to cost close to $1,000,000.